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Training to Improve the Organization of Tactical Knowledge: An Evaluation of the Armor Tactical Concepts Tutor

John E. Morrison and Eugene H. Drucker
Human Resources Research Organization International, Inc.

Richard P. Kern
U.S. Army Research Institute

Max W. Foster
Human Resources Research Organization International, Inc.

Automated Instructional Systems Technical Area
Robert J. Seidel, Chief

Training Research Laboratory
Jack H. Hiller, Director

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EDGAR M. JOHNSON
Technical Director

JON W. BLADES
COL, IN
Commanding

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Technical review by

Joseph Hagman

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The U. S. Army Research Institute sponsored the development of a computer-based, interactive video training system called the Armor Tactical Concepts Tutor (ARTACT). ARTACT was designed to address training problems observed in the Armor Officer Basic Course (AOBC). The objectives of the experimental evaluation were to try-out ARTACT in AOBC; to determine its effects on knowledge retention, organization, and processing; and to assess student reactions and perceptions to the system. Sixty student volunteers from five AOBC classes were randomly assigned to either an experimental or control group. Students in the experimental group received training on ARTACT in addition to their normal training in AOBC. Students in the control group received AOBC training only. All students were tested on their knowledge of tactics both before and after training on ARTACT. At the posttest, students in the experimental group were also asked for their subjective impressions of ARTACT. 25 * Computer assisted instruction *

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Researchers found that--

- While there were large decreases in error rate between pretest and posttest, ARTACT students showed 12% greater improvement than the control group. This superiority was consistent across all tactical objectives tested.

- Both the experimental and control groups showed changes in the types of reasoning expressed during tactical problem solving indicative of increasing tactical expertise. However, no difference was found between the two groups.

- No differences were found between the two groups on class standing or on the Armor School's tactical test scores.

- Students' reactions to incorporating ARTACT into AOBC were generally positive, but with qualifications for desired improvements.

TRAINING TO IMPROVE THE ORGANIZATION OF TACTICAL KNOWLEDGE: AN EVALUATION OF THE ARMOR TACTICAL CONCEPTS TUTOR

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Introduction

The Armor Officer Basic Course (AOBC) is a 16-week (plus two days) course of instruction for training newly commissioned armor officers. AOBC trains officers in two different and complex duties: that of tank commander and that of platoon leader. In addition to providing skills and knowledge required to perform these two critical duties, AOBC is important to armor's mission in that it provides the foundation for officer training in the Armor Branch. In fact, it is the only formal course work that the second lieutenant will receive prior to being assigned as a platoon leader. It is crucial that AOBC instruction be effective in developing the basic knowledge and skills that a second lieutenant needs to command a tank and to lead an armor platoon.

Transfer of Training Problems in AOBC

Kern (cited in Bryant et al., 1987) studied AOBC as it was conducted in 1984 and conceptually divided the course into two phases. In the first phase (the first two-thirds of the course), students learned basic facts and procedures that focused on characteristics, capabilities, maintenance, and operation of equipment. Because most new lieutenants had little or no armor tactical background, this focus fostered the perception that training had only some obscure relevance to whatever platoon leaders might need to know and do in planning and conducting tactical operations. Instruction in the second phase (the last third of the course) focused on teaching the student tactical concepts employed in maneuvering the tank platoon to accomplish various offensive operations and in preparing and defending battle positions. Learning these tactical concepts and how to employ them during practice and during performance tests required the student to recall and appropriately apply facts and procedures taught in the first phase. Examples of facts and procedures that are relevant to tactical concepts include the effective range of weapons, the CEOI for encoding and decoding radio messages, hand-and-arm signals, tank formations, and techniques of movement.[1]

Student test scores from phases 1 and 2 documented the steep decrease in performance when the focus of instruction shifted from learning relatively discrete facts and procedures to learning how to integrate this diverse knowledge with the new knowledge being learned in phase 2. Whereas first-attempt pass rates for the first phase of AOBC were greater than 93 percent, the corresponding performance for the second phase of training dropped to approximately 70 percent. The types of errors made suggested that students were finding it especially difficult to recall and appropriately integrate

[1]Since the 1984 observations, AOBC has been extended from 15 weeks to 16 weeks, 2 days. In addition, hand-and-arm signals and techniques of movement training were rescheduled to occur in the initial part of the second, or tactical, training phase.

knowledge learned in the first phase of the instruction into the tactical context of the second phase.

An extensive body of research literature suggests that students would be expected to exhibit failures in retrieving and applying knowledge learned in one context to solving problems encountered in a different context (e.g., Bransford, Sherwood, Vye, & Rieser, 1986; Barsalou, 1988; Franks, Bransford, & Auble, 1982). When the AOBC was designed in 1984, very few explicit linkages were made in phase 1 between the facts and procedures being trained and their significance to the planning or conducting of tactical operations. Since that time the Armor School has worked on improving the linkages between knowledge taught in phase 1 and the tactical training taught in phase 2. However, the extensive amount and diversity of information presented in phase 1 are too large to be easily retained and retrieved, especially if the student only receives the information in the classroom and does not use it in any operational context until he reaches phase 2. In other words, the transfer problem may be due to lack of sufficient exercises in establishing the relationships between facts and procedures taught in phase 1 to tactical objectives taught in phase 2. In recognition of these problems, the tactical instructors provide additional training in phase 2 consisting of one-on-one practice in conducting tactical operations on terrain boards as well as additional tutoring during the final field exercises. While this approach is recognized as effective, it is clearly labor intensive and limited by the number of available instructors. Furthermore, even greater effectiveness might be achieved if training were designed so that the student recognized the need for retrieving appropriate phase 1 knowledge when he enters phase 2 tactical training.

A second contributor to the transfer problem relates to the students' use of ineffective cognitive strategies for learning and storing information presented in long-term memory. Despite the considerable information processing demands of the course, Kern (cited in Stoddard, Kern, & Emerson, 1986) observed that many AOBC students persisted in using simple, inefficient strategies (primarily, rote memorizing) to acquire and retain information. As a result, these students did not interrelate facts and procedures taught in phase 1 with possible implications for their significance to later performance requirements. Thus, when they entered the tactical context of phase 2, they were unable to retrieve information that was stored by rote memorization and had to relearn it in the new context. Stoddard et al. (1986) hypothesized that, in contrast to students, experts in tactics (i.e., senior NCOs and officers) are able to readily apply tactical information to actual problems because their knowledge of tactics-related facts and procedures is organized in a manner that facilitates effective retrieval. This speculation was based on a growing body of research showing differences between experts and novices in knowledge organization and processing in a variety of content areas (e.g., Glaser, 1984). The implication from this hypothesis is that AOBC training should be designed to encourage and assist the student in developing a more highly interrelated knowledge base starting early in AOBC.

Development of the Armor Tactical Concepts Tutor

The Armor Tactical Concepts Tutor (ARTACT) was developed by ARI with the assistance of the Cognitive Engineering Design and Research Team from the Los Alamos National Laboratory. The objective in designing ARTACT was to provide the Armor School with prototype computer-tutor programs that would cause the student to perform the types of cognitive processing needed to develop a more highly interrelated knowledge base starting early in AOBC. ARTACT is a prototype system in that it is intended only to provide a sufficient number of programs needed to demonstrate its potential and, if accepted, to provide a shell that could accept additional programs.

The ARTACT programs are designed to be inserted at various points during the facts and procedures training (phase 1) that precedes the armor tactical training (phase 2). The objective of these programs is to train the student to interrelate appropriate facts and procedures taught in phase 1 within the context of tactical operations before he reaches phase 2 training. To accomplish this, four interactive videodisc programs were developed. Identified by their tactical context, these four are described as follows:

1. Planning Field Artillery Fires: Planning target locations and type of fires to defend a battle position.

2. Techniques of Movement, Formations and Battle Drills: Scenario-based planning and execution of movement from battle position to objective.

3. Offensive Operations: Scenario-based planning and execution with responses to unexpected problems.

4. Defensive Operations: Scenario-based planning and execution with responses to unexpected problems.

These programs put the students in a simulated context of planning and conducting tactical operations. The scenarios used are designed to require students to recognize the need for retrieving and applying appropriate facts and procedures taught in preceding classes of phase 1. Thus, the primary objective of ARTACT is to augment the regular phase 1 instruction by training students to interrelate knowledge learned in phase 1 with knowledge to be taught in phase 2. Since the students will receive these programs before receiving tactical training, it was necessary that they provide tutoring on basic tactical knowledge when students are otherwise unable to proceed. As a result, a secondary objective of ARTACT is to tutor students on basic tactical knowledge.

ARTACT programs were given a full doctrinal review by subject matter experts from the Tank Platoon Tactics committee in September 1987, and changes required were made prior to initiation of this evaluation.

Purposes of the Evaluation

The overall purpose of the present study was to conduct a small-scale evaluation of ARTACT. The evaluation focused principally on the effects of ARTACT on student performance. To determine these effects, the performance of a group of students who received ARTACT instruction was compared to the performance of another group who did not receive ARTACT instruction using a pretest/posttest design. This evaluation represented the first use of ARTACT in an instructional setting. Therefore, an additional purpose of the evaluation was to identify problems in operating ARTACT in a realistic setting and to assess subjective reactions to the system. The data obtained from the evaluation may be grouped according to the following four sets of evaluation issues.

Effects on Tactical Knowledges and Skills

This issue related to the question of whether or not ARTACT training, conducted prior to the regular tactical training, resulted in greater knowledge for planning and conducting tactical operations. Special tests on the subset of AOBC tactical skills and knowledges addressed by ARTACT were administered to all participants near the beginning and at the end of AOBC.

Effects on Organization of Tactical Knowledges

This issue reflects an important assumption underlying the rationale used in the design of ARTACT. However, there are no well established methods for assessing organization of a person's knowledge of a given topical domain that can serve as evaluative criteria. Consequently, new techniques were developed to assess the organization of students' knowledge structures. If feasible, these techniques could provide empirical evidence on the relationship between the quality of students' performance and the types of organization of knowledge they had achieved. Because of their experimental status, any findings concerning the effectiveness of ARTACT that are based on these techniques should be regarded as suggestive.

Effects on Performance in AOBC

This issue addressed the effects of ARTACT training on student performance in AOBC. Two types of AOBC measures were obtained: (a) overall performance in AOBC based on the student's class standing (percentile rank) and average academic grades, and (b) scores from the Armor Performance Test, an examination administered in the 14th week of AOBC that focuses on tactical skills and knowledges.

Formative Issues

Because this study is the first field test of ARTACT, two formative evaluation issues were addressed: (a) the identification of ARTACT software and hardware problems evident from operating the system in AOBC, and (b) the assessment of subjective reactions of AOBC students to the ARTACT system.

Method

Experimental Participants

Participants in the present experiment were students from six consecutive AOBC classes undergoing training in FY 1988. Names of 12 or more volunteers from each of the six classes were provided to the experimenters who randomly assigned six students to the experimental group and six to the control group. Students in the experimental condition received training on ARTACT whereas students in the control condition did not. Hardware and software problems precluded implementing all four ARTACT modules in the first class; consequently, the data from the first class were not used. Of the remaining five classes (60 students), two students assigned to the experimental group withdrew from ARTACT for medical or personal reasons. Six other students (3 experimentals, 3 controls) failed to show up for the posttest and graduated from AOBC before they could be tested. Therefore, the pre-post comparisons were based on a total of 52 AOBC students, 25 in the experimental group and 27 in the control. Variations to these sample sizes are noted in relevant sections of the Results.

All students were initially given a questionnaire to determine their background and experience. A copy of this questionnaire is provided at Appendix A-1, and a descriptive summary of these data is presented at Appendix B. The summary indicates that the majority of students participating in the experiment received their commission from the Reserve Officer's Training Corps (ROTC) and were serving in the reserve component, either the Army Reserve or the Army National Guard. In terms of military experience, the students had about 1.5 - 2 years experience prior to AOBC. Finally, the overwhelming majority of students (51 out of 52) reported some kind of computer experience. Analyses revealed no significant differences between experimental and control groups on any of these background and experience variables except in one case: computer experience related to use of a computer at work. In that particular case, a higher proportion of experimental students reported having computer experience at work compared to control students.

Assessing Effects on Tactical Knowledges

To determine whether or not students retained factual knowledges learned from ARTACT, two tactical scenarios were prepared for a tactical knowledge test. The test consisted of either a defensive or offensive tactical scenario, both of which were similar in content to exercises presented in AOBC as well as those presented in ARTACT. Student responses were recorded on audio tape and were later transcribed for scoring. Both forms of the test were designed to be administered orally on an individual basis. The test began with a recorded company-level OPORD. A written copy of the OPORD and a tactical overlay were available to the student throughout the test.[2] The experimenter then read from a prepared script that started with the platoon in

[2]The support of the Platoon Tactics Branch of the Armor School's Command and Staff Department is acknowledged for providing the OPORD and overlays.

an assembly area, moved them through some imaginary events to which the student described his actions, and concluded with completion of the mission. A copy of the OPORD, tactical overlay, and experimenter instructions for both the offensive and defensive scenario are attached at Appendix C. Imbedded in the instructions were multiple questions designed to test the student's knowledge of tactics. Included in the instructions (but not provided to students) are the responses that the experimenters deemed "correct" for scoring purposes. The two forms of the test were designed to be comparable to the extent that they both contained an approximately equal number of items that addressed the following eight objectives:[3]

1. Given a company mission and time to plan; the student must plan platoon operations in accordance with standard troop leading procedures including analyzing METT-T factors and key avenues of approach, issuing a warning order, and executing a physical reconnaissance.

2. Given a mission requiring movement toward some objective; the student must select an appropriate route.

3. Given a route to the objective and information on the tactical situation; the student must select an appropriate movement technique and movement formation.

4. Given a movement technique and formation; the student must recognize the hand-and-arm signals corresponding to that technique and formation.

5. Given a movement formation; the student must specify the relative position of tanks within the platoon including the gun tube orientations of each tank.

6. Given a mission requiring field artillery support; the student must formulate an appropriate indirect fire plan including locating preplanned targets, selecting symbols for each target (point, area, and line), and determining shell/fuze combinations.

7. Given that platoon operations are underway; the student must react appropriately to surprise situations that may occur including encountering targets at and beyond direct fire range, obstacles such as streams or minefields, etc.

8. Given a situation requiring communication; the student must recognize when to authenticate a message, when to execute a platoon fire command, and when to provide a SPOTREP or SITREP.

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[3]The sponsors, developers, and evaluators informally agreed that these eight statements provided a fair representation of ARTACT's objectives.

Assessing Effects on Organization of Tactical Knowledges

"Talk Aloud" Protocols

The instructions for the tactical knowledge test encouraged students to "talk aloud" as they answered the test questions. These instructions were modified from those provided by Ericsson and Simon (1984) in their textbook on protocol analysis. One of the experimenters performed a content analysis of student protocols revealing ten categories of student comments that were incidental to their answers but reflective of knowledge organization and processing. All transcripts were scored by this experimenter who identified and counted the number of instances of each type of comment while remaining "blind" with respect to group membership. It should be stressed that these comments were scored independently from their "correctness," which is reflected in error rates on the tactical knowledge test. Reliability of scoring scheme was examined by having a second experimenter score six of the student transcripts independently using an initial set of instructions for differentiating the categories.

CHALLENGE

CHALLENGE is an experimental computer program under development by Kern and Legree (1988). The objective of the program is to assist students in organizing their knowledge of a particular topical domain. The program is designed to be used repeatedly by students involved in a course of instruction. However, in this evaluation it was used only during pretest and posttest to reflect changes in scope and quality of students' organization of their tactical knowledge.

The CHALLENGE program presents the student with a central topic previously entered by the experimenter. In essence, the instructions ask the student to generate and edit a keyword outline to represent his or her understanding of the central topic. In this evaluation, the central topic was "what you need to know to plan an armor platoon operation." Summarizing from Kern and Legree (1988), the activities presented by CHALLENGE may be described by three sequential phases of actions:

1. The students were first asked to list the major concepts, procedures, or "things you need to know" to understand the central topic. The current version of CHALLENGE used in the present experiment (CHALLENGE II) allows the student to list up to eight different major topics. However, because of time limitations in the present research, AOBC students were instructed to generate a maximum of five such major topics.

2. The students were then asked to generate "supporting points" for each of the major topics presented one at a time. Supporting points are subordinate elements that the student considers important for understanding each major topic. Students were allowed to list up to eight different supporting points for each major topic.

3. The final process required the student to rate each supporting point in terms of its importance to understanding each of the major topics. The CHALLENGE program uses these data to generate various measures that tap the interrelationships between major topics.

Assessing Effects on Performance in AOBC

The intent of the final set of performance data was to determine whether or not ARTACT training affected performance in AOBC. To make this determination, academic records were obtained for every student assigned to the experiment. The records consisted of scores on academic tests given throughout AOBC and students' final class standings expressed in percentile ranks. In addition, records of student performance on the Armor Performance Test were obtained. This particular test is an integrative exercise that taps many of the same tactical skills and knowledges addressed in ARTACT. The test consists of two components: (a) a paper-and-pencil knowledge test and, (b) a hands-on performance test based on a simulated tactical scenario and administered by instructors using a terrain board. In the interest of test security, the specific items on the test cannot be revealed.

Collecting Formative Data

Since the present experiment represented the initial implementation of the programs, the research provided an opportunity to collect formative evaluation data concerning the ARTACT modules and associated hardware and software. The purpose was to determine how well the software and hardware functioned and to identify software and hardware changes that could improve the effectiveness of the programs. Two types of data were obtained for this formative evaluation: (a) a record of software and hardware problems that occurred during the implementation of the four ARTACT modules, and (b) subjective reactions of the subjects as measured on a questionnaire administered at the end of the study.

Record of Software and Hardware Problems

During the research, a record was kept of all problems that were experienced during the implementation of ARTACT.

AOBC/ARTACT Questionnaire

A questionnaire was prepared to assess subjective reactions to ARTACT. The first five items, which were administered to students in both the experimental and control groups, dealt with issues related to AOBC. The specific subjects of these items and predictions concerning the expected differences between experimental and control groups are described below:

1. The difficulty levels of eleven topics presented in AOBC. Assuming that ARTACT were effective, it was expected that the AOBC topics that were covered in ARTACT would be perceived to be less difficult by students in the experimental group than by students in the control group. No differences between the two groups were expected for topics that were not covered in ARTACT.

2. Interest in AOBC instruction on tactics. Assuming again that ARTACT were effective, interest in AOBC tactics instruction was expected to be higher among students in the experimental group.

3. Preparedness for the 10-day field exercise presented at the end of AOBC. On the assumption that ARTACT were effective, it was expected that the students in the experimental group would benefit more from their AOBC instruction and would perceive themselves to be better prepared for the 10-day field exercise given at the end of AOBC.

4. Knowledge of planning and executing platoon tactics. It was anticipated that as a result of their ARTACT participation, the students in the experimental group would perceive themselves to be more knowledgeable in planning and executing platoon tactics.

5. Preparedness to serve in combat as the leader of a tank platoon. It was anticipated that the students in the experimental group would perceive themselves to be better prepared to serve as a platoon leader in combat.

Ten additional items, which were administered only to students in the experimental group, assessed their reactions to ARTACT. Specifically, these 10 items dealt with the following ARTACT issues: (a) student perceptions of ARTACT, (b) their suggestions for program improvements, and (c) their recommendations concerning the role that ARTACT could perform in AOBC. A copy of the experimental group questionnaire, which includes all 15 questions items, is attached at Appendix A-2.

Procedure

The experimental procedure was organized around three major events: (a) the pretest, (b) the ARTACT training sessions, and (c) the posttest. Each of these three events is described in detail below.

Pretest

Students in both experimental and control groups were initially tested in Week 4 of AOBC. Three types of data were obtained at that time. The first of these related to background information on the students. Students provided these data in response to a written questionnaire. (See Appendix A-1.) Following the questionnaire, students interacted with the CHALLENGE program to determine their initial knowledge organization for planning a platoon operation. Student output from CHALLENGE was saved on hardcopy printouts and on floppy diskettes. After CHALLENGE, the experimenters administered the tactical knowledge test on an individual basis while tape recording student responses. Approximately half of the students received the offensive scenario while the other half received the defensive scenario. The entire pretest lasted approximately 1.5 - 2 hours.

ARTACT Training Sessions

Students received the training in individual sessions scheduled for up to two hours each. Two student work stations were available for conducting this training and were located in the Armor School's Professional Development Center.[4] Table 1 shows the scheduling planned for the four modules of ARTACT versus the corresponding blocks of AOBC instruction.

Table 1

Correspondence Between Planned Schedules of ARTACT Modules and AOBC Classes

ARTACT Modules		AOBC Classes	
Topic	Week of AOBC	Topic	Week of AOBC
Planning FA Fires	5th	Platoon Fire Plans	14th
Techniques of Movement	7th	Techniques of Movement	12th
Offensive Operations	12th	Fundamentals of Offense	13th
Defensive Operations	13th	Fundamentals of Defense	14th

Student time for working on these programs could not conflict with scheduled AOBC instruction and had to come from the students's personal time, such as evenings and time off during weekends. As a result, the week that a student actually received a particular ARTACT program sometimes deviated from the planned schedule. Missed appointments and system failures (in the first two weeks) were responsible for most of the deviations. The distribution of actual times that students received ARTACT training is shown in Table 2.

Student time to complete each of the four ARTACT modules is shown in Table 3. Although the sessions were monitored by a member of the research staff, all of the instruction was presented by the ARTACT system. Planning Field Artillery (FA) Fires was the shortest module and the only one that students worked through twice within the same session.

[4]Each work station consisted of a Zenith 248 computer, a Pioneer LDV 6010A laser videodisc player, two Sony color video monitors (model PVM-1271Q), an ALPS dot matrix printer, and an audio headset.

Table 2

Distribution of Actual Times Students Were Trained on ARTACT Modules

ARTACT Module	Week of AOBC									
	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th
Planning FA Fires	15	2	4	5	2					
Techniques of Movement			17	0	7	1	3			
Offensive Operations							3	8	16	1
Defensive Operations									16	12

Table 3

Student Time to Complete ARTACT Modules

ARTACT Module	Time (in mins)	
	MDN	*RNG*
Planning FA Fires (Once)	20	12-35
Techniques of Movement	55	35-110
Offensive Operations	45	30-70
Defensive Operations	55	40-95

Posttest

Students in both groups were tested for a second time in Week 16. Students were asked to complete three activities. The first activity was to retake the CHALLENGE program under exactly the same instructions used in the pretest. The second activity was to take the alternate version of the tactical test. That is, students who received the offensive tactical scenario on the pretest were assigned the defensive scenario for the posttest (test order A), whereas those whose received the defensive scenario on the pretest were given the offensive scenario on the posttest (test order B). The third posttest activity required the students to fill out a questionnaire that addressed their perceptions of AOBC. The experimental students were also given additional questions relating to their perceptions of ARTACT. Like the pretest, the entire posttest session lasted 1.5 - 2 hours.

Design and Analysis

In the analysis of variance (ANOVA) design used to analyze performance data, students were nested into either control or experimental conditions (groups) and crossed with repeated test administrations (trials). Variations and elaborations to this basic design are noted in the relevant sections of the Results. Because ARTACT was administered between the pretest and the posttest, the effects of ARTACT were evaluated by the group X trials interaction term. Given a significant interaction, simple effects analyses were performed using the within-subject error term to determine the differences between pretest and posttest within one of the two groups. To test differences between groups either at the pretest or at the posttest, the error term was pooled between-subjects and within-subjects yielding a "within cell" estimate of variance. The significance of this effect was estimated using a *t*-approximation method attributed to W. G. Cochran and described in Lindquist (1953). For analyses involving more than two dependent measures, univariate ANOVAs were supplemented with multivariate analyses of variance (MANOVAs) to protect against violations of the compound symmetry assumption in univariate ANOVAs. Following advice from Wilkinson (1986), if the results from the two analyses disagreed, the decision from the MANOVA took precedence because it does not require this assumption.

Results and Discussion

The results of the evaluation are organized into sections corresponding to individual evaluation issues. The sections begin with details on data scoring procedures, if applicable. The first four sections present the results from four groups of performance measures, all of which measure different aspects of the students' knowledge of tactics. To determine the relationships between these performance measures, one or two of the most representative variables from each of these four groups of performance variables were selected for a correlational analysis, the results of which are presented in Appendix D. The intercorrelations calculated over both the experimental and control groups are presented in Table D-1 with correlations within these groups presented in Tables D-2 and D-3 respectively. Findings from this correlational analysis are discussed in the appropriate results sections along with the findings of other analyses of the data. Each section concludes with a short summary of the results of the analyses.

Effects on Tactical Knowledges: Errors on the Tactical Knowledge Test

Data Scoring Procedures

Tape recordings of student responses to the tactical knowledge test were transcribed and then scored for accuracy. Technical problems resulted in the failure to record the posttest responses of one student in the control group. His data were excluded from these analyses resulting in *n*s of 25 and 26 for experimental and control groups, respectively. For each student, an error rate was calculated for each of the eight test objectives covered in the tactical scenarios. The error rate was defined as the number of errors committed divided by the total number of scoreable items for that particular objective. Because the final two objectives (Surprise Events and Reports) were based on only four and two items respectively, performance in some of the experimental subgroups had no variance. Consequently, results from both objectives were combined to make a single objective for purposes of analysis. The design used to analyze these data set students nested into test orders (A or B) as well as into groups forming a between-groups 2 X 2 factorial design (group X test order). Students were also crossed with the resulting seven test objectives and the two test administrations.

Results of the Analyses

Effects on overall performance. Table 4 presents mean error rates over all test objectives of the tactical knowledge test for experimental and control groups. The most obvious trend in these data is that students in both groups committed substantially fewer errors on the posttest than on the pretest. Analyses of these data (summarized in Appendix Table E-1) confirmed that these trends were highly significant, F (1, 47) = 344.34, $p < .001$. Furthermore, decreases in error rate were significant for both experimental and control groups, Fs (1, 27) = 126.43 and 226.35, respectively, both ps < .001. However, the experimental group showed a greater decrease in errors from pretest to posttest than did the control group as indicated by the

Table 4

Means and Standard Deviations of Overall Error Rates on the Tactical Knowledge Test

Group		As Measured at Pretest	As Measured at Posttest
Experimental	*M*	0.66	0.29
	SD	0.11	0.07
Control	*M*	0.61	0.34
	SD	0.11	0.10

significant group X trial interaction, F (1, 47) = 8.16, $p < .01$. As can be seen in Table 4, the interaction was disordinal in that the relationship between experimental and control groups was reversed from pre- to posttest. As a result of this disordinal relationship, the differences between groups at the pretest and at the posttest were small and nonsignificant (both ps > .10). Nevertheless, the significant interaction indicated that improvement in performance between pretest and posttest was greater for the experimental than for the control group.

Effects on performance on individual test objectives. Table 5 allows an examination of these same trends by individual test objectives. The table shows large differences in error rates among the objectives, which were shown to be statistically significant, F (6, 282) = 16.00, $p < .001$. Furthermore, there were differences in performance gains among the objectives. That is, performance on some objectives (e.g., hand-and-arm signals) improved more than performance on other objectives (e.g., indirect fire planning). The corresponding ANOVA effect (objective X trial) was confirmed to be significant, F (6, 282) = 18.84, $p < .001$. Despite the differences in performance gains among objectives, the table shows that the trend for greater performance improvement in experimental than in control students is evident on every objective. This observation is supported by the fact that the group X objective X trial interaction was not significant, $F < 1$. Thus, the analyses support the contention that the effect of ARTACT was uniform across training objectives.

Table 5

Means and Standard Deviations of Error Rates on Individual Objectives of the Tactical Knowledge Test

Test Objective	Group		As Measured at Pretest	As Measured at Posttest
Troop Leading Procedures	Experimental	*M*	0.72	0.34
		SD	0.20	0.34
	Control	*M*	0.72	0.36
		SD	0.21	0.30
Route Selection	Experimental	*M*	0.49	0.35
		SD	0.17	0.19
	Control	*M*	0.47	0.33
		SD	0.15	0.19
Movement Technique/Formation	Experimental	*M*	0.71	0.46
		SD	0.23	0.16
	Control	*M*	0.55	0.49
		SD	0.19	0.24
Hand-and-Arm Signals	Experimental	*M*	0.70	0.07
		SD	0.27	0.14
	Control	*M*	0.58	0.11
		SD	0.27	0.14
Formation Drawing	Experimental	*M*	0.70	0.16
		SD	0.24	0.12
	Control	*M*	0.58	0.18
		SD	0.25	0.17
Indirect Fire Planning	Experimental	*M*	0.54	0.36
		SD	0.21	0.17
	Control	*M*	0.56	0.49
		SD	0.21	0.18
Surprise Events/Reports	Experimental	*M*	0.73	0.31
		SD	0.23	0.24
	Control	*M*	0.77	0.41
		SD	0.17	0.24

Test order was included in these analyses as a control variable. The main effect of test order was not significant nor were any of the first order interactions with order. The only interaction with test order that was significant according to both univariate and multivariate criteria was the triple order X objective X trial interaction, F (6, 282) = 5.84, $p < .001$. To explain this interaction, the performance data were broken down by test order (A or B), test objective, and trial and are presented in Table 6. The mean values indicate that there were differences between the offensive and defensive scenarios on individual objectives. For instance, the data indicated more errors on the defensive scenario than on the offensive scenario for route selection, whereas this relationship is reversed for surprise events/reports. Although there were minor differences between test versions, the lack of interaction between test order and group membership suggests that test order had no mitigating effect on any of the previous findings.

Table 6

Mean Error Rates on Tactical Knowledge Test by Objective, Test Order, and Trial

Test Objective	Test Order[a]	As Measured at Pretest	As Measured at Posttest
Troop Leading Procedures	A	0.73	0.40
	B	0.71	0.29
Route Selection	A	0.47	0.39
	B	0.49	0.28
Movement Technique/ Formation	A	0.64	0.40
	B	0.62	0.56
Hand & Arm Signals	A	0.60	0.06
	B	0.67	0.12
Formation Drawing	A	0.58	0.14
	B	0.70	0.20
Indirect Fire Planning	A	0.51	0.44
	B	0.61	0.41
Surprise Events/Reports	A	0.82	0.26
	B	0.67	0.47

[a]Test order A denotes that students took the offensive version of the tactical knowledge on the pretest and the defensive version on the posttest. Test order B indicates that the student took the test versions in the opposite order.

As revealed in the Method section (Table 2), scheduling problems resulted in some students not receiving ARTACT at the planned time with respect to corresponding units of instruction. Post hoc analyses were conducted to contrast the performance of students who received ARTACT as planned versus those who received ARTACT after the planned time. Results of these analyses showed no differences in performance on the tactical knowledge test as well as other variables.[5] These findings suggest that ARTACT's effects were not dependent on strict adherence to the planned schedule.

Correlations with other knowledge variables. Appendix D indicates that there were more significant bivariate correlations involving the tactical knowledge test than any of the other knowledge measures. Of the eighteen correlations involving the pre- and posttest administrations of the tactical knowledge test, six were significant at the .05 level and three more approached significance--i.e., *p*s < .10. The correlations of performance on this variable to other knowledge variables provide evidence for its validity as a measure of tactical knowledge.

Summary

The findings from these analyses may be summarized by three generalizations:

1. There were large decreases in error rate between pretest and posttest in both experimental and control groups. In view of the fact that students took a different form of the tactical knowledge test at the posttest, it is unlikely that all or even most of this large performance improvement was due to repeated testing. It is more likely that most of this improvement was due to the students' intervening experience, i.e., their AOBC course work.

2. Students in the ARTACT group improved more than those in the control group. This finding supported the hypothesis that students learn and apply the subset of AOBC knowledges tutored in ARTACT.

3. The greater improvement for the ARTACT group was uniform across all of the seven performance objectives.

Effects on Organization of Tactical Knowledge: 1. Talk Aloud Protocols

Data Scoring Procedures

As a result of the instructions to "talk aloud," students provided verbalizations that were incidental to the questions posed in the tactical knowledge test. The analysis of these additional verbal data was begun by performing a content analysis of student verbalizations from the first AOBC class whose data were not included in the results. Ten categories or types of

[5]Details on these analyses may be obtained from the authors.

incidental verbalizations were identified along with examples of each from actual student transcripts. Types of verbalizations included elaborations on how procedures are performed as well as reasons for choosing particular responses. Appendix F defines each of these ten categories and provides verbatim examples of each type from student transcripts. After establishing these categories of responses, transcripts from the remaining five classes were read to identify every occurrence of these verbalizations. The mean number of occurrences of each type of comment was tabulated for each student. The mean number of comments is displayed in Appendix Table F-1. In decreasing frequency of occurrence, the ten categories of comments were:

1. Reasons related to specific characteristics of the situation or of the prescribed action.

2. Reasons related to predicted outcomes of prescribed actions.

3. General principles that guide responses.

4. Reasons related to information in the original OPORD or FRAGO.

5. Reasons related to anticipated enemy actions.

6. Procedural information on "how to" perform a task.

7. Reasons related to the students interpretation of the mission.

8. Reasons based solely on doctrine or SOP or some other rote tactical rule.

9. Reasons based on personal preference.

10. Evidence of some mnemonic or imaginal coding.

These categories of incidental verbalizations were examined as possible indicants of the types of knowledge that students used to answer questions on the tactical knowledge test. Upon examination, it was determined that the two least frequent categories (personal preference and mnemonic coding) had no clear relation to knowledge and were therefore not considered further. Of the remaining eight categories, six constituted statements of the students' reasons for their answers to questions on the tactical knowledge test, while two did not reflect reasons per se, but were indicative of knowledge development.

Classification of "reasons-for-answers-given" categories. The six categories reflecting reasons for answers given were recombined according to the "level" of knowledge that they were determined to represent (Perkins & Salomon, 1989). At the lowest or most specific level of knowledge were reasons based on the local or proximal conditions that control performance. This level of knowledge is specific in the sense that it is applicable only to the domain in question and is therefore characteristic of the expert

performer. The response categories corresponding to this level of knowledge were reasons based on specific characteristics and information provided in the OPORD/FRAGO (categories 1 and 4). This level is labeled Specific Knowledge in Table 7.

Two categories (categories 7 and 8) contain reasons based on the student's interpretation of the mission or on doctrine and SOP. These reasons appear to reflect an intermediate level of knowledge in that they are domain-specific, but based on abstractions rather than on local conditions. This level is labeled Intermediate Level in Table 7.

The remaining two of the six "reasons-for-answers-given" categories (categories 2 and 5) were classified as knowledges at a higher level of generality, reflecting heuristics applicable to tactics as well as to other knowledge domains. General heuristics are characteristic of the sophisticated novice. The term "sophisticated" is meant to imply that, in order to use general heuristics, the student must recognize the applicability of what he already knows to a new domain--something that students do not necessarily do. Responses classified into this level of knowledge were reasons based on the predicted outcomes of a response or on the anticipated actions of the enemy. This level is labeled General Heuristics in Table 7.

The numbers of comments characteristic of each of three levels of knowledge were tabulated for each student. The number of comments within each level was analyzed separately setting students nested into groups and crossed with repeated test administrations (trials).

Comments not presented as reasons for answers given. The two remaining categories of incidental comments (categories 3 and 6) were not reasons per se, but they were indicative of knowledge development. The first category (Table 8) is where the student offered some statement of general principles that could be used to guide responses but were not used to justify any specific response. For instance, one student said that his choice of movement technique would be based on the likelihood of enemy engagement, but he did not indicate how the choice was actually made. These sorts of responses may be examples of declarative knowledges (facts) that have not been compiled into useable procedures (Anderson, 1982) and are typical of the early stages of learning.

The remaining category of comments is where the student provided unsolicited procedural information on how to perform a particular task (Table 8). For instance, when asked what to do when faced with direct fire from identifiable enemy tanks, some soldiers not only said that they would issue a platoon fire command, they also described the content of that fire command. This sort of response may be the converse of previous type of comment in that the student demonstrates elaborate knowledge of procedure. As in the previous case, data in these two categories were analyzed separately. Due to the low frequency of comments within these categories, these data did not meet the normality and homogeneity of variance requirements of parametric

analyses. Consequently, soldiers in both groups were classified as either having increased in the number of comments, decreased in number, or showed no change across the repeated test administrations. These frequency data were then analyzed using chi-square techniques.

Scorer reliability. To check on the reliability and objectivity of the scoring of the incidental verbalizations, two experimenters independently scored the same six transcripts. The correlations between experimenters on the number of instances across the five categories in the revised scheme ranged from 0.53 to 0.99+ with an average 0.78. Detailed analysis of the differences between scorers revealed two types of discrepancies: (a) failures of one or the other experimenter to recognize instances of certain types of comments, and (b) disagreements in classifications of comments. The first type of discrepancy was reduced over repeated cycles of scoring and review, i.e., with practice. The second type of discrepancy was reduced by clarifications to the definitions of the categories. Although a perfect 1.0 correlation between scorers is probably not possible given the difficulties noted by the experimenters in interpreting student transcripts, the findings suggest that higher levels of agreement could have been achieved. On the basis of these findings, the scoring method was deemed adequately reliable and objective.

Results of the Analyses

Effects on generality of problem-solving reasoning. Table 7 presents the mean frequency of comments corresponding to the knowledge levels discussed above. The most notable trend in these data are the changes in the frequency of occurrence across repeated test administrations: Whereas the comments indicative of specific knowledge increase across the test trials, the comments related to general heuristics decrease. Analyses of these data (Appendix Table E-2) indicated that both of these changes across trials were statistically reliable, Fs (1, 49) = 4.08 and 4.37, respectively, both ps < .05. The increase in specific knowledge comments would confirm the students' increasing expertise in tactics. The decrease in general heuristics comments also reflects increasing expertise in accordance with the hypothesis offered by Alexander and Judy (1988): "... as the learners' knowledge of the content relative to that task increases, then it is likely that the need for strategic behavior [i.e., use of general heuristics] decreases" (p. 375). Comments relating to the intermediate level of knowledge were relatively less frequent than the other two categories with little change across trials. Analysis of this level indicated that the difference between trials was not significant, $F < 1$. The second trend notable in Table 7 is that the changes in comments related to specific knowledges and general heuristics were more pronounced in the experimental group than in the control group. However, the analyses did not confirm this observation: The group X trial interaction was not significant in any of the three analyses.

Table 7

Means and Standard Deviations of the Frequency of Student Comments Associated With Three Levels of Knowledge Generality

Knowledge Level	Group		As Tested at Pretest	As Tested at Posttest
Specific Knowledge	Experimental	*M*	3.72	4.92
		SD	1.84	2.40
	Control	*M*	4.62	4.92
		SD	2.06	2.73
Intermediate Level	Experimental	*M*	0.32	0.40
		SD	0.56	0.71
	Control	*M*	0.35	0.42
		SD	0.74	0.90
General Heuristics	Experimental	*M*	4.00	3.08
		SD	3.57	1.60
	Control	*M*	3.73	3.08
		SD	2.31	2.19

Effects on types of incidental knowledges. Table 8 displays the frequency and percent of students in each group classified as either increasing, not changing, or decreasing in the number of comments related to general principles or procedural information. An equal proportion of students (about 35% overall) increased as decreased in their comments related to general principles. Furthermore, the table shows more experimental students increasing than decreasing in frequency of comments, whereas the control group shows the opposite tendency. However, a chi-square analysis of these data indicates that the group differences were not significant, Chi^2 (2) = 2.80, p = .25. In contrast, nearly 40% of the students evidenced an increase in comments related to procedural information with no students showing decreases. This tendency is slightly more pronounced in the control group. However, analysis of cells with non-zero observed frequencies indicated that the group differences were not significant, Chi^2 (1) = 0.21, p = .65.

Table 8

Frequency and Percent of Soldiers in Groups Classified by Their Change in Number of Comments from Pre- to Posttest

Comment		Change in Number of Comments from Pre- to Posttest		
		Increase	No Change	Decrease
General Principles				
Experimental	*f*	10	9	6
	%	40	36	24
Control	*f*	8	6	12
	%	31	23	46
Procedural Information				
Experimental	*f*	9	16	0
	%	36	64	0
Control	*f*	11	16	0
	%	41	59	0

Correlations with other knowledge variables. Appendix D presents the correlations of the frequency of comments related to specific knowledge and general heuristics to each other and to other performance measures. The previous analyses of means clearly indicated that these two types of comments were, to some degree, independent as evidenced by the change in their relative position as a function of trials. Nevertheless, the correlation analysis indicated that these measures were positively related to each other at the pretest and the posttest, although the correlation at the posttest only approached significance, $p < .07$. Another notable observation from this analysis is that the incidence of these comments at the pretest was correlated with the incidence at the posttest. A plausible explanation of these correlations is that students differ with respect to their willingness to "talk aloud" and that those who provided one sort of comment were likely to provide a comment of the other sort as well. These data can also be interpreted as supporting the generalization offered by Alexander and Judy (1988) that specific knowledge and general heuristics are inextricably related in at least two ways: (a) some minimal level of specific knowledge must be

achieved to use general heuristics, and (b) general heuristics can improve the use of specific knowledge. Finally, perhaps the most interesting finding from this analysis is that the incidence of both types of comments were negatively related to the error rate on the tactical knowledge test, i.e., higher incidence of comments were associated with lower error rates. These correlations were significant at the pretest (both *p*s <.01), but only approached significance at the posttest, *p*s < .10. Unfortunately, the present correlational data cannot be used to determine whether use of specific knowledge and general heuristics strategies *caused* better performance on the knowledge test, or whether these verbalizations and test performance were correlated with some enduring student trait (e.g., intelligence). Nevertheless, these findings suggest that use of knowledge at either the specific or general level is associated with good performance, a finding which is consistent with the literature (Alexander & Judy, 1988).

Summary

Two major generalizations may be drawn from these data:

1. The changes in types of comments from pretest to posttest were generally indicative of increasing tactical expertise. In particular, the increase in problem-solving reasons based on specific knowledge and the increase in procedural knowledge support this trend. In addition, the decrease in use of general heuristics may indicate that students relied less on strategies indicative of the novice performer as their expertise developed.

2. These findings failed to show greater changes in the experimental as opposed to the control group. That these trends were evident in the control as well as the experimental group implied that the primary cause of these shifts in types of comments was AOBC instruction and not ARTACT tutoring.

Effects on Organization of Tactical Knowledge: 2. The CHALLENGE Program

Data Scoring Procedures

Two types of data were obtained from CHALLENGE. The first category of data related to the student's confidence in the results of CHALLENGE. As a last step in the CHALLENGE program, students rated their confidence in the central topic on a 100-point scale. As stated earlier, the central topic for CHALLENGE was "what you need to know to plan an armor platoon operation." Due to technical problems, the pretest confidence ratings of one student who was assigned to the control group were lost. Consequently, his data were excluded from the following analyses resulting in *n*s of 25 and 26 for the experimental and control groups, respectively. The remaining CHALLENGE data are based on *n*s of 25 and 27 for experimental and control groups.

The second type of data obtained from CHALLENGE pertained to the content of the structures. Examination of student responses revealed four doctrinally recognized schemata used to generate and organize items in CHALLENGE. Of these four, the most frequently used approach was to organize the major topics around the factors used to analyze tactical missions: mission, enemy, terrain

(and weather), troops, and time available; or METT-T. Another popular approach was to generate major topics using the five paragraph headings in an operations order (OPORD): situation, mission, execution, service support, and command and signal. A third approach to organizing responses was to use all or a subset of the eight troop leading procedures used to prepare a platoon for an operation: receive and analyze the mission, issue the warning order, form a tentative plan, start necessary movement, conduct reconnaissance, make decisions/complete the plan, issue the OPORD, and supervise and refine. A final scheme was to use the acronym OCOKA (observation, cover and concealment, obstacles, key terrain, and avenue of approach) to generate supporting points usually under a major topic relating to terrain. The output from CHALLENGE was examined to identify instances where students used any one of these schemata to generate major topics or supporting points. Examination of the these data indicated that students sometimes used more than one of these schemata. For instance, several students used the five elements of METT-T as major topics and the acronym OCOKA for generating supporting points under the concept "terrain." This finding suggested that student output could be scored two ways. First, a binary variable (1 or 0) was used to describe whether or not students used any of the aforementioned schemata to organize their CHALLENGE responses. Second, an interval measurement variable was used to describe the number of detectable schemata used by each student. The latter variable ranged in value from 0 to 4.

Results of the Analyses

Effects on confidence in the central topic. Mean ratings of confidence in the central topic are presented in Table 9 broken down by group and test administration. Inspection of the table reveals an increase in confidence going from pre- to posttest. Analyses of these date (Appendix Table E-3) indicated that this difference was reliable, F (1, 49) = 14.32, $p < .001$. The other evident trend is higher confidence ratings in the control than in the experimental group. This trend also proved statistically significant, F (1, 49) = 4.69, $p < .05$. The means also suggested the presence of a group X trial interaction as evidenced by the larger gains in confidence in the experimental compared to the control group. However, this interaction did not prove to be significant, $F < 1$. Thus, these data failed to indicate an increase in confidence as a function of ARTACT training.

Effects on schemata usage. The data in Table 10 include means and standard deviations of variables relating to (a) whether or not students used any of the four identified schemata in generating or organizing their responses to the CHALLENGE program, and (b) the number of instances of schemata usage. Both performance variables are broken down by group and test administrations. The findings from the two sets of results are very similar in two respects. First, there is a marked increase in the use of schemata on the second compared to the first test administration. Separate ANOVAs of these two sets of data (Appendix Table E-4) indicate that the trials effect was reliable for both the binary and interval measure variables, Fs (1, 50) = 17.60 and 11.00, respectively, both ps < .01. Second, the experimental group evidenced larger increases than the control group in schemata usage across the

Table 9

Means and Standard Deviations of Ratings of Confidence in the Central Topic

Group		As Measured at Pretest	As Measured at Posttest
Experimental	*M*	77.6	89.2
	SD	22.5	9.3
Control	*M*	86.9	93.7
	SD	11.7	9.9

Table 10

Means and Standard Deviations of Variables Relating to Use of Doctrinal Schemata to Organize Responses in CHALLENGE

Variability Source	Group		As Measured at Pretest	As Measured at Posttest
Presence of Any Schemata				
	Experimental	*M*	0.36	0.84
		SD	0.49	0.37
	Control	*M*	0.48	0.67
		SD	0.51	0.10
Number of Instances of Schemata Use				
	Experimental	*M*	0.36	1.40
		SD	0.49	1.08
	Control	*M*	0.48	1.04
		SD	0.51	0.94

two test administrations. In spite of the trends, however, the group X trial interaction terms approached but did not exceed conventional significance levels in either case, *F*s (1, 50) = 3.46 and 2.84, respectively, both *p*s < .10.

Correlations with other knowledge variables. Appendix D presents the correlations between the binary variable used to index students' use of doctrinal schemata in organizing their knowledge during the CHALLENGE sessions and the other knowledge variables. Use of doctrinal schemata as organizers during the pre- and posttest sessions was positively, but not significantly correlated ($p < 10$). Use of doctrinal schemata during the pretest session was associated with lower error rates on the tactical knowledge test administered during this same session. However, this relationship was not replicated during the posttest session.

Taking a somewhat different perspective, the correlations in Table D-1 suggest that during the pretest session the poorer performers on the tactical knowledge test tended to be those who were less likely to use schemata organizers when working on the CHALLENGE program. However, the direction of this relationship reverses when pretest knowledge test scores are correlated with use of schemata organizers during the posttest session. That is, higher error rates on the pretest knowledge test were associated with higher incidences of use of schemata organizers during the posttest CHALLENGE session. In other words, students who made more errors in the pretest tactical knowledge test became those students most consistent in using schemata organizers to describe their understanding of operations during the posttest CHALLENGE session.

The lack of relationship during the posttest session between students' use of doctrinal schemata and the posttest knowledge test is probably due to the large percent of students in both groups who used doctrinal schemata during this session. That is, as shown in Table 10, 84% of the experimentals and 67% of the controls used one or more schemata organizers during this session. Apparently this more uniform use of schemata organizers during the posttest session wiped out any relationship with posttest performance on the tactical knowledge test.

It should also be noted that students who used doctrinal organizers during the pretest session did not display an understanding that involved interrelating these highly interrelated organizers. That is, if one of the four doctrinal schemata scored was used, it did not incorporate significant parts of any of the other three. However, during the posttest session on CHALLENGE, 32% of the experimental group and 30% of the control group interrelated two to four of the doctrinal schemata in outlining their understanding of planning a tactical operation. The difference between the two groups is not statistically significant. The importance of this trend is in documenting a change in the ability to organize their doctrinal knowledge as a reflection of the learning taking place and their stage in this process.

Summary

Results from data analyses of the CHALLENGE data may be summarized by the following generalizations:

1. Comparison of pre- and posttest performance reflected increasing expertise in tactics as indicated by (a) an increase in students' confidence in their understanding of knowledge needed for planning tactical operations, and (b) increases in the number of students using doctrinal schemata to describe their understanding of planning tactical operations and in the number of such schemata used by students.

2. Despite some trends in the hypothesized direction, the analyses were consistent in their failure to indicate any advantage of experimental over control group, thereby failing to attribute changes in knowledge organization to experience with ARTACT.

Effects on Performance in AOBC

Data Scoring Procedures

Measures of AOBC classroom performance were divided into two categories. The first category comprised measures of overall performance in AOBC including the students average grade on all scored course work and the student's percentile rank within his class. The second category comprised measures of performance on the Armor Performance Test administered in Week 14 of AOBC, subsequent to ARTACT training. Student performance on this test was recorded on a pass/fail basis for individual test objectives within either the written and performance components of the test. For the written component of the test, each of the 11 test objectives consisted of a single item. In contrast, the 11 test objectives of the performance components consisted of multiple test items. Unfortunately, performance data on individual items of the performance component were not maintained in the student records.

Data on AOBC performance included the six students (three experimentals and three controls) who did not show for the posttest. Data from these students were included because they all had complete AOBC records and because the three students in the experimental group had completed ARTACT training. However, the analyses did not include the two experimental students who dropped from the program prior to ARTACT training. Consequently, the following comparisons were based on *n*s of 28 and 30 for experimental and control groups, respectively.

Results of the Analyses

Effects on overall performance. Table 11 summarizes the overall performance in AOBC for experimental and control groups. For both measures, performance of the experimental group is superior to that of the control group. However, the differences are not large, especially in light of the large between-subjects differences, i.e., the standard deviations. Univariate analyses of these data (Appendix Table E-5) indicated that in neither case

Table 11

Overall Performance in AOBC

Performance Measure		Group: Experimental	Group: Control
Class Average	*M*	93.0	91.7
	SD	3.2	2.7
Percentile Rank	*M*	54.9	40.8
	SD	27.8	26.7

were the differences between groups significant, although the difference in percentile rank approached significance at the .05 level, F (1, 56) = 3.89, $p < .06$.

Effects on the Armor Performance Test. Table 12 displays the percent of test objectives passed for both the written and performance components of the Armor Performance Test. For both test components, performance of the experimental group was superior to that of the control group. Again, however, the differences are not large in reference to between-subject variability. The analysis on these data (Appendix Table E-6) showed no significant differences between groups or between test components, nor was the interaction of these two factors significant.

Table 12

Percent Objectives Passed for the Two Components of the Armor Performance Test

Test Component		Group: Experimental	Group: Control
Written	*M*	86.0	84.2
	SD	12.0	9.8
Performance	*M*	83.7	77.7
	SD	17.2	17.5

The next analysis addressed differences between objectives within the written component. Of the eleven objectives within this component, two were related to ARTACT: one to the Offensive Operations module and the other to the Defensive Operations module.[6] The remaining nine objectives were not related to ARTACT. The top portion of Table 13 indicates that there is an apparent tendency for the differences between groups to be larger for the objectives that are related to ARTACT. However, examination of performance on individual objectives indicates that this overall tendency appeared only on the item related to Offensive Operations and not on the item related to Defensive Operations. Analyses of these data (Appendix Table E-7) showed no significant effects due to group, the type of test objective, or their interaction.

Table 13

Performance on Objectives Within Written and Performance Components of the Armor Performance Test

Relation of Objective To ARTACT		Group: Experimental	Group: Control
Written Component			
Related	*M*	85.7	81.7
	SD	26.7	27.8
Not Related	*M*	86.1	84.7
	SD	12.7	10.3
Performance Component			
Most Items Related	*M*	82.1	70.0
	SD	24.4	31.1
Half of Items Related	*M*	78.6	71.7
	SD	31.7	36.4
Few of Items Related	*M*	80.9	76.6
	SD	24.7	26.5
None of Items Related	*M*	87.5	86.7
	SD	32.3	34.6

[6]For reasons of test security, the specific items cannot be revealed.

Differences between objectives in the performance component were more difficult to describe due to the fact that objectives comprised multiple items. Some of these items were related to ARTACT skills and knowledges, and some were not. A simple scheme was devised to describe this relationship by creating four categories of objectives defined as having most, half, few, or none of the items related to ARTACT. As a result of this exhaustive classification scheme, at least two objectives were assigned to each of these four categories with the few category consisting of three objectives. The bottom portion of Table 13 indicates a direct relationship between the experimental/control differences and the degree to which the objectives were related to ARTACT. That is, the experimental group's advantage was larger for test objectives that were more closely related to ARTACT. Despite these promising trends evident in the means, none of the effects of the analyses were significant (Appendix Table E-7). The nonsignificance of these data may be attributed to the large between-student variability as evidenced by the standard deviation values. The large variability, in turn, is partly due to the fact that performance within each category was based on only two or three test items.

Correlations with other knowledge measures. According to conventional standards for statistical significance, the only reliable relationship between the Armor Performance Test and other knowledge measures was the negative correlation between performance on the written component of the Armor Performance Test and errors on the tactical knowledge pretest, $r = -.30$, $p < .04$. In other words, higher scores on the written component were associated with lower error rates on the knowledge pretest. A similar negative relationship was evident between performance on the written component and performance on the tactical knowledge posttest, but it was not significant, $p < .08$. Other correlations with the Armor Performance Test that approached but did not exceed significance at the .05 level included (a) the positive correlation between the two components of the Armor Performance Test, $p < .06$; (b) the positive correlation between the written component and specific knowledge comments, $p < .07$, and (c) the positive correlation between the performance component and specific knowledge comments, $p < .10$. Thus, the overall pattern of intercorrelations support the validity of these measures, including the Armor Performance Test, as indexes of individual differences in tactical knowledge.

Summary

The trends evident in the descriptive statistics suggested that experimental students performed better than control students on all measures of AOBC performance. Furthermore, the performance component of the Armor Performance Test indicated larger experimental-control differences for those test objectives that were most related to ARTACT. Despite the consistency of these trends, none were statistically significant. Thus, the AOBC data failed to unambiguously show that experience with ARTACT positively transfers to AOBC performance and written tests.

Formative Evaluation:
1. Performance of ARTACT Hardware and Software

Results

The most frequently occurring hardware/software problem encountered during the evaluation was a module's "freezing," i.e., stopping at some point in program and not responding to student input. These freezes usually required the experimenter to restart the program from the beginning. Table 14 and the following paragraphs elaborate on problems experienced in each of the four ARTACT programs:

1. Planning FA Fires. No problems were experienced when administering the Planning FA Fires module.

2. Techniques of Movement. The Techniques of Movement program froze while being administered to six of the seventeen students in the first three classes. The cause of the problem was eventually corrected, and the program did not freeze at all when administered to the students in the last three classes. The program was restarted whenever it froze, and all students were able to complete the module.

3. Offensive Operations. The Offensive Operations module did not run properly when it first arrived, and the problem was not corrected in time to administer the program to the students in the first class. Consequently, the class was dropped from the study. The program was sufficiently improved so that it could be administered to the students in the second class, but the problems were never totally corrected. The program froze at the very end for all six students in the second class and for three of the five students in the third class. Although these nine students completed the program before it froze, they were unable to receive a printout of their performance, and all records of their performance were lost. The program also froze four times prior to the end while it was being administered to students in the third, fifth, and sixth classes, and it had to be restarted each time. Since the program ran properly after being restarted, printouts were available for all four students, and all data were saved.

4. Defensive Operations. Although the Defensive Operations module did not run when it first arrived, the program was sufficiently improved so that it could be used. However, the program froze four times prior to the end. It was restarted each time and then ran properly. Consequently, printouts were available for all students, and all data were saved.

Table 14

Number of Students Experiencing a Program Freeze During the Implementation of an ARTACT Program

ARTACT Program	AOBC Class 1	2	3	4	5	6	Total
Planning FA Fires							
Froze During Program	0	0	0	0	0	0	0
Froze at End of Program	0	0	0	0	0	0	0
Did Not Freeze	6	6	5	5	6	6	34
Total Number of Students	6	6	5	5	6	6	34
Techniques of Movement							
Froze During Program	1	2	3	0	0	0	6
Froze at End of Program	0	0	0	0	0	0	0
Did Not Freeze	5	4	2	5	6	6	28
Total Number of Students	6	6	5	5	6	6	34
Offensive Operations							
Froze During Program		0	1	0	1	2	4
Froze at End of Program		6	3	0	0	0	9
Did Not Freeze		0	1	5	5	4	15
Total Number of Students		6	5	5	6	6	28
Defensive Operations							
Froze During Program		0	1	1	1	1	4
Froze at End of Program		0	0	0	0	0	0
Did Not Freeze		5	4	4	5	5	23
Total Number of Students		5	5	5	6	6	27

Summary

The Planning FA Fires program was free of problems throughout the field test. Initial problems that caused the Techniques of Movement program to freeze were eliminated early in the field test. However, problems with the Offensive Operations and Defensive Operations programs continued sporadically throughout the field test. The influence these problems may have had on students' subjective reactions to ARTACT will be considered in the next section.

Formative Evaluation: 2. Responses to Structured Questionnaire Items

Appendix A-2 presents the version of the questionnaire given to the experimental students during the posttest session. The version given to the control students contained only the first five items which deal with AOBC but not ARTACT. These five items were not included in the questionnaire administered to the students from the second AOBC class, i.e., the first class whose data were included in the analysis. Consequently, data on these items were obtained from 19 students in the experimental group and 21 in the control group. The questionnaire contained three types of items requiring different scoring procedures, each of which is described below.

The first item in the questionnaire required the students to rate the difficulty they experienced in understanding each of 11 topics of instruction in AOBC. Students were instructed to make their ratings on a 100-point scale where "1" was extremely easy and "100" was extremely difficult. Examination of the training objectives associated with the 11 AOBC topics revealed that they could be classified as either related or unrelated to ARTACT's content. Related topics were those six AOBC content areas (Table 15) that were covered, at least in part, by one or more ARTACT modules. Unrelated topics were those remaining five AOBC content areas (Table 15) that were not covered by ARTACT.

The next group of structured items on the questionnaire consisted of (a) four questions designed to assess the subjective reactions of the experimental and control groups toward AOBC, and (b) five questions designed to assess the reactions of the experimental group toward ARTACT. Students responded to each of these items using a 5-point scale. The responses were coded such that "5" represented to most positive response and "1," the least positive.

The final two structured items on the questionnaire were summary questions asking students in the experimental group (a) to specify which ARTACT program they found most helpful, and (b) to state whether or not they believed ARTACT should be adopted in AOBC. These two forced-choice items were scored by counting the number of students selecting each alternative.

Results of the Analyses

Effects on rated difficulty of AOBC topics. The ARTACT programs were designed to be administered at various points in training prior to receiving the regular, related armor tactical training. Assuming the ARTACT programs

were effective in enabling students to more readily comprehend the regular instruction in AOBC, it was expected that experimental students would rate the related topics easier to understand than would the control students.

Table 15 presents means and standard deviations of ratings on each topic broken down by experimental and control conditions. These data indicated that the groups rated related and unrelated topics in a manner that was contrary to expectations: Whereas the experimental and control group did not differ very much in their ratings of unrelated topics (means = 37.8 and 38.7, respectively), the experimental group rated the related topics substantially more difficult than control group (means = 44.9 and 34.6, respectively). The data were subjected to analysis with students nested into either experimental or control groups and crossed with the 11 question items (i.e., AOBC topics). The results of the analysis are contained in Appendix Table E-8.

A result from this analysis that is relevant to the present hypothesis was the significant interaction between topic relatedness (related, unrelated) and groups, F (1, 38) = 4.10, $p < .05$. Analysis of individual means indicated that two differences approached but did not exceed conventional values for statistical significance: (a) the difference between experimental and control groups in their ratings of related topics, t (38) = 1.36, $.20 > p > .10$; and (b) the difference between related and unrelated topics for the experimental group, t (18) = 1.83, $p < .10$. Despite the failure to obtain reliable differences between individual means, the significant interaction between topic relatedness and groups confirmed that the differences between the ratings of related and unrelated topics were dependent upon group assignment. Thus, the ratings made by students who had received ARTACT training prior to the related classroom instruction suggest they perceived the AOBC instruction as more difficult to understand than did the students who did not receive ARTACT training. Speculations on what this may signify will be addressed in the Discussion section of this report.

Effects on subjective reactions to AOBC. Means and standard deviations of subjective reactions to AOBC are displayed in the upper half of Table 16. The means indicate that students reacted generally favorably toward AOBC with no apparent differences in reaction to individual questions. Analyses of the data (Appendix Table E-9) indicated no reliable differences in ratings due to group or to question item, and no differences due to the group X question interaction.

Subjective reactions to ARTACT. Means and standard deviations of the subjective reactions to ARTACT are displayed in the bottom half of Table 16. Although the means indicate that students reacted generally favorably toward ARTACT, there are more marked differences in student reactions to questions. Post hoc comparisons[7] indicated that students rated the useability of the computer more highly than the intrinsic interest, helpfulness, or effectiveness of the ARTACT programs, t (24) = 3.24, $p < .004$. In contrast,

[7]Using the Bonferroni procedure, alpha was adjusted by dividing by the number of possible comparisons (six). The resulting significance criterion for these comparisons was .0083.

Table 15

Means and Standard Deviations of Difficulty Ratings of Topics in AOBC[a]

Topic of Instruction		Group: Experimental	Group: Control
Related to ARTACT			
Command and Control	*M*	34	33
	SD	23.8	27.2
Techniques of Movement	*M*	37	28
	SD	30.0	29.0
Cavalry Operations	*M*	53	45
	SD	28.8	28.7
Fundamentals of Reconnaissance	*M*	45	36
	SD	27.8	25.3
Fundamentals of Offense	*M*	51	32
	SD	29.4	29.7
Fundamentals of Defense	*M*	50	33
	SD	29.6	29.7
Unrelated to ARTACT			
Engineers and Mobility/Counter-Mobility Operations	*M*	29	42
	SD	24.7	30.8
Call For and Adjust Indirect Fire	*M*	61	61
	SD	29.2	29.7
Tactical Air Operations	*M*	31	31
	SD	32.8	27.0
NBC Defensive Operations	*M*	32	25
	SD	27.2	22.2
Fundamentals of Security	*M*	36	34
	SD	25.7	23.3

[a]Ratings were made on a scale from 1 to 100 with higher ratings indicating greater difficulty.

Table 16

Means and Standard Deviations of Responses to Questionnaire Items Pertaining to AOBC and ARTACT Rated on a Five-Point Scale[a]

Questionnaire Item		Group: Experimental	Group: Control
Items Pertaining to AOBC[b]			
How interesting was the AOBC classroom instruction on tactics?	*M*	4.0	4.1
	SD	1.16	0.89
How prepared were you for applying tactical knowledge during the 10-day war?	*M*	3.9	4.1
	SD	0.74	0.44
In your opinion, how knowledgeable are you in planning and executing platoon tactics?	*M*	3.9	3.9
	SD	0.57	0.44
As a result of having participated in AOBC, how prepared are you to serve in combat as the leader of a tank platoon?	*M*	3.6	3.9
	SD	0.60	0.66
Items Pertaining to ARTACT[c]			
How helpful were the ARTACT programs as a way of learning about platoon tactics?	*M*	3.4	
	SD	1.39	
How hard was it to learn to use the computer to work on the ARTACT programs?	*M*	4.3	
	SD	1.07	
How interesting were the ARTACT programs?	*M*	3.2	
	SD	1.27	
How effective were the ARTACT programs in getting you to think about platoon tactics?	*M*	3.6	
	SD	1.19	

[a]A rating of "5" indicated most favorable reaction and "1", least favorable.

[b]The *n*s for the items pertaining to AOBC were 19 for the experimental group and 21 for the control group.

[c]The *n* for the items pertaining to ARTACT was 25.

differences in ratings between the latter three questions were not significant.

Effects of software/hardware problems on subjective reactions to ARTACT. Additional analyses were performed to determine if student reactions to ARTACT were negatively influenced by the software and hardware problems that occurred during ARTACT training. The students in the experimental group were separated into two groups based on the need to restart a program during ARTACT training. None of the modules had to be restarted for fifteen students of the students, while at least one module had to be restarted for the other ten students. Means and standard deviations of reactions to ARTACT are displayed in Table 17 for each of the two groups of students. The means indicate that there are marked differences in the reactions of the two groups on all four items with the students in the restart group showing the more favorable reaction to ARTACT. This finding was certainly contrary to expectations. A post hoc analysis of these data (Appendix Table E-10) indicate significant main effects for group (F (1, 43) = 4.43, $p < .05$) and for questions (F (3,69) = 8.07, $p < .001$), but not a significant interaction between these two factors.

Table 17

Means and Standard Deviations of Responses to Questionnaire Items Concerning ARTACT for Students Who Restarted an ARTACT Program and Those Who Did Not

Questionnaire Item		Restarted an ARTACT Program[a] Yes	No
How helpful were the ARTACT programs as a way of learning about platoon tactics?	*M*	3.9	3.1
	SD	1.22	1.36
How hard was it to learn to use the computer to work on the ARTACT programs?	*M*	4.9	3.9
	SD	0.30	1.18
How interesting were the ARTACT programs?	*M*	3.6	3.0
	SD	1.11	1.26
How effective were the ARTACT programs in getting you to think about platoon tactics?	*M*	4.10	3.2
	SD	0.83	1.22

[a]The *n*s were 10 for the group that restarted an ARTACT program and 15 for the group that did not.

Responses to ARTACT summary questions. Table 18 presents the student responses to the two summary questions contained in the questionnaire. The responses to the question concerning the most helpful ARTACT program revealed that the majority of the students found Planning FA Fires to be most helpful. This finding was unexpected given that module has the least overlap with AOBC instruction. Perhaps students found ARTACT most helpful when it provided new information. The responses also revealed that none of the students chose Defensive Operations as the most helpful program. The Defensive Operations program was the last one to be presented to the students. Consequently, they already had been exposed to the other three programs, and they had almost completed their classroom training when exposed to the Defensive Operations program. Given these circumstances, it is possible that the students perceived the program to be the least helpful because they had already learned much of the information it contained.

Table 18

Responses of Students in Experimental Group to Summary Questions Concerning ARTACT

Question Items Alternative Responses	*f*	%
Which ARTACT program did you find most helpful?		
Planning FA Fires	13	59
Offensive Operations	5	23
Techniques of Movement	4	18
Defensive Operations	0	0
	22[a]	
In your opinion, should the ARTACT programs become part of the AOBC curriculum?		
Yes	6	24
Yes, but only if they are improved	13	52
No	6	24
	25	

[a]Although 25 students responded to this item, the responses made by three students were uninterpretable.

The second summary question involved their opinion concerning the implementation of the ARTACT programs in AOBC. The majority of students (76%) stated that ARTACT should be implemented, although 52% felt that it should be implemented only if the programs are improved. To determine if the software and hardware problems affected their opinions concerning the implementation of the program, the students were separated into two groups based on the need to restart a program during ARTACT training. Table 19 presents the student responses to this question for the two groups of students. The data appear to show that fewer students rejected the implementation of ARTACT in AOBC if they had to restart the program during training. Due to the small frequencies in most of the cells, the number of students who responded "YES" and the number who responded "YES, BUT ONLY IF THEY ARE IMPROVED" were summed, and a Fisher's exact test was performed to compare the response frequencies of the two groups. The result showed that the difference in the responses between the two groups was not significant (p = .35).

Table 19

Responses to Summary Question Concerning Implementation of ARTACT in AOBC for Students Who Restarted and Did Not Restart an ARTACT Program

Questionnaire Item	Restarted an ARTACT Program: Yes		Restarted an ARTACT Program: No	
	f	%	*f*	%
In your opinion, should the ARTACT programs become part of the AOBC curriculum?				
Yes	4	40	3	20
Yes, but only if they are improved	5	50	7	47
No	1	10	5	33
	10		15	

Summary

Results from the analyses of responses to structured questionnaire items may be summarized as follows:

1. The experimental and control groups differed in their ratings of the difficulty of AOBC topics. Contrary to expectations, the experimental group rated topics that were related to prior tutoring received in ARTACT as more, rather than less, difficult than did the control group. The groups did not differ with respect to their ratings of topics not related to tutoring received in ARTACT.

2. Experimental and control group were equally favorable in their ratings of the interest level of classroom instruction ("quite interesting") and the extent to which they were prepared for the 10-day war, for planning platoon tactics, and for serving in combat as a tank platoon leader ("quite prepared").

3. Average ratings of ARTACT programs made by students in the experimental group showed that the programs were perceived as "somewhat" interesting and helpful in learning about platoon tactics. They were rated slightly higher ("somewhat to quite" effective) in their effectiveness in getting them to think about platoon tactics. Learning how to use the computer to run ARTACT was not perceived to be difficult. Surprisingly, the ARTACT students rated the Planning FA Fires module as the most helpful of the four modules even though the topic was no longer presented in AOBC.

4. The majority (76%) of the students in the experimental group felt that ARTACT should become part of the AOBC curriculum, although two-thirds of these students were in favor of its adoption only if the programs are improved. Opinions on the types of improvements considered important are discussed in the section following this summary.

5. The ratings of the ARTACT programs were subjected to post-hoc analyses to determine if students who experienced software and hardware problems had less favorable reactions to ARTACT than students who did not experience these problems. Contrary to expectations, the results showed that students who experienced such problems had more favorable, not less favorable, reactions to ARTACT. However, the presence or absence of these problems did not relate to student opinions concerning the adoption of ARTACT in AOBC.

Formative Evaluation:
3. Responses to Unstructured Questionnaire Items

Data Scoring Procedures

Responses of students in the experimental group to the four open-ended questionnaire items were read through for content, and tentative response categories were proposed. Student responses were then sorted into the categories. The categories were examined for purity and for the accuracy of category labels. Appropriate changes to the categories were made, and the items were resorted into the final configuration. To examine some of the factors that perhaps related to student's reactions to these questions, students in the experimental group were classified three ways: (a) whether or not they experienced problems during ARTACT, (b) whether they were in the top or bottom half of their AOBC classes, and (c) whether students were above or below the median in improvement from the first to the second administration of the tactical knowledge test.

Results of the Analyses

Three of the four open-ended questionnaire items asked the students in the experimental group to describe what they liked most about the ARTACT programs, what they disliked most about the programs, and what improvements or changes they felt should be made. The final unstructured item provided the students an opportunity to make any other comments or suggestions. The responses to these four items are summarized in Table 20 and are described briefly below. A more detailed analysis of student responses to the four items and breakdowns according to uncontrolled events and student characteristics are provided in Appendix G.

Most liked aspects of ARTACT. The positive aspects of ARTACT that were cited most often were its role in helping to prepare for AOBC classes (nine students) and the feedback that the programs provided (six students). Another category of answers focused on specific characteristics of the programs that some students particularly liked such as the graphics or the way the content was organized (five students). Responses to this item (Appendix Table G-1) were unrelated to the students' rank in their AOBC class except for one response category where the relationship approached statistical significance: Seven of the thirteen students in the top half of their class praised ARTACT's role in helping to prepare for AOBC compared to just two of the twelve students in the bottom half of their class, $p = .097$. This finding suggests that the better students tended to recognize the important role that ARTACT could serve in AOBC. Finally, responses to this item were unrelated to the experience of a software or hardware problem on ARTACT, i.e., having to restart a program.

Most disliked aspects of ARTACT. The most frequent complaint about ARTACT dealt with problems in scheduling and the time required (six students). Other complaints focused on deviations from doctrine (eight students), specific aspects of the programs that some students particularly disliked such as the emphasis on movement formations and techniques (six students), and ARTACT's rigidity in accepting student responses (seven students). Responses to this item (Appendix Table G-2) were unrelated to either the students' rank in their AOBC class or the experience of a software or hardware program on ARTACT.

Recommended improvements and/or changes in ARTACT programs. The most frequent answers dealt with improving various program characteristics such as increasing their flexibility in accepting answers and in allowing deviations from doctrine (six students). Other recommendations that were frequently made focused on improving or changing the software or hardware (six students), the map display (four students), the feedback (four students), and the scenarios (four students). Responses to this item (Appendix Table G-3) were unrelated to the students' rank in their AOBC class except for one response category: Four students in the top half of their class recommended improvements or changes in the feedback provided by ARTACT compared to none in the bottom half of their class, $p = .039$. The relationship approached statistical significance on one other response category: Only one student in the top half of his AOBC class recommended software or hardware improvements compared to five students in the bottom half of their class, $p = .073$. These findings

Table 20

Responses to Unstructured Questionnaire Items Presented by Response Cluster

Questionnaire Item / Response Cluster	Number of Students Responding	Number of Responses Made
What do you like most about the ARTACT programs?		
Preparation for the AOBC Classes	9	10
Program Characteristics	5	8
Feedback	6	7
Information Learned	4	4
Research Personnel	3	3
Miscellaneous	3	3
No Response	2	
What do you dislike most about the ARTACT programs?		
Scheduling	6	10
Differences from Doctrine	8	9
Specific Aspects of the Programs	6	9
Rigidity of Programs	7	8
Quality of Map Display	4	4
Equipment Problems	3	3
Miscellaneous	3	3
No Response	2	
What Improvements or changes should be made in the ARTACT programs?		
Program Characteristics	6	10
Software/Hardware	6	7
Map Display	4	5
Feedback	4	5
Scenarios and Missions	4	5
Uses for ARTACT	3	5
Consistency with Classroom and Doctrine	4	4
Scheduling	3	3
Miscellaneous	2	2
No Response	3	
Other comments or suggestion		
Negative Comments	5	13
Suggestions	7	8
Comments on ARTACT Staffmembers	4	6
Positive Comments	4	5
No Response	11	

suggest that the better AOBC students tended to focus on the benefits that ARTACT could provide in AOBC, whereas the poorer students tended to focus on the reliability of the system. Finally, responses to this item were unrelated to the experience of a software or hardware problem on ARTACT.

Other comments and suggestions. Although all but two or three students responded to the questions summarized above, only 14 of the 25 students responded to this final question. One response category contained specific suggestions such as the suggestion that ARTACT training be scheduled on weekday evenings or that students should be able to repeat a part of the program after their mistakes have been identified (seven students). The other categories contained negative comments relating to ARTACT (five students), positive comments relating to ARTACT (four students), and positive comments relating to the evaluation staff (four students). Responses to this item (Appendix Table G-4) were unrelated to the students' rank in their AOBC class. They were also unrelated to the experience of a software or hardware problem on ARTACT except for one response category: Four of the ten students who restarted a program praised the evaluation staff compared to none of the fifteen students who did not restart a program, $p = .017$. This finding suggests that the students appreciated the efforts of the research staff to provide each student an opportunity to complete all four ARTACT modules.

Summary

The responses made to the four open-ended questions can be summarized as follows:

1. The students in the experimental group had both positive and negative reactions to ARTACT.

2. While many of ARTACT's characteristics were praised, no single characteristic was cited frequently. Many of the students reacted favorably toward the learning experiences that ARTACT provided, particularly toward its role in helping them prepare for AOBC.

3. Many of the students saw the need to improve the programs. Deviations from doctrine and the rigidity of the programs were common complaints. Although scheduling was a frequently mentioned problem, it would probably not remain one if ARTACT were adopted by AOBC.

4. Students who were most successful in AOBC (i.e., ranked in the top half of their class) recommended improvements in the feedback provided by ARTACT and provided more praise for ARTACT's role in helping them prepare for AOBC classes. Students who were least successful in AOBC (i.e., ranked in the bottom half of their class) recommended improvements in ARTACT's software and hardware.

General Discussion

The procedure used to experimentally implement ARTACT merits further discussion. In order to experimentally control exposure to ARTACT, students in the experimental group were required to attend the training sessions for all four modules, each under the supervision of the research staff. Students were not allowed any additional voluntary exposures to ARTACT. In contrast to this procedure, ARTACT was designed to be used by the students alone and on an ad libitum basis. One could argue that the procedure used in the present study caused ARTACT to be implemented suboptimally because it allowed no more that 6-8 hours of contact with the system. On the other hand, AOBC students are relatively busy during the 16 weeks of their training. Given these time pressures, it is likely that many students would not have completed all four modules voluntarily. In that regard, the experimental procedure insured that all students in the experimental group had, at least, the minimum exposure to ARTACT; i.e., they completed each of the four modules. In either case, interpretation of the effects of ARTACT should be tempered by the fact that it was not implemented in the manner that it was designed to be used in practice.

Effects on Retention of Specific Skills and Knowledges

The results clearly indicated that students improved in performance across repeated test sessions on those tactical skills and knowledges trained in ARTACT. Most of this improvement was probably due to AOBC training itself. Nevertheless, the strong impact of AOBC training on test performance provided additional validation that the skills and knowledges trained on ARTACT are integral to AOBC. This empirical finding is in agreement with previous rational analyses (Bryant et al., 1987) indicating that the content of ARTACT includes integrative, high level skills and knowledges that span the AOBC curriculum. But the more important finding was that students in the experimental group improved above and beyond those students in the control group. The latter result indicated that exposure to ARTACT had a positive effect on gains in test performance. Taken together, these findings imply that ARTACT had a positive effect on the student's preparation for their subsequent tactical training.

Effects on the Organization and Processing of Tactical Knowledges

The results also showed that students changed in the processing of their tactical knowledges from a style characterized primarily by the use of general heuristics on the pretest to one primarily characterized by the use of specific knowledge on the posttest. The students showed an analogous change in their knowledge organization evidenced by the increase in their use of doctrinally recognized schemata and in their ability to interrelate these in describing their understanding of planning tactical operations. All of these changes were indicative of increasing expertise in tactics. Although ARTACT students tended to consistently show greater changes in improved organization of knowledge than did the controls, these differences were not statistically significant. Thus, in contrast to the results from the knowledge test, there was no clear evidence that ARTACT had an effect on the process of gaining expertise greater than that attributable to AOBC. One conclusion that might be drawn from these data is that, although ARTACT was effective in training

specific tactical knowledges, it did not have the desired effect on the fundamental manner in which students organize and process these knowledges. This interpretation is consistent with the finding that accretion of expertise is a relatively long-term phenomenon, not likely to be greatly affected by the short-term exposure to ARTACT. On the other hand, one might also speculate that these cognitive changes were too subtle and the measures were too insensitive to detect the effects of ARTACT over the overwhelming effects of AOBC on knowledge structure and process. The nonsignificant trends in the hypothesized direction lend some credence to the latter interpretation.

Effects on Performance in AOBC

The evaluation also attempted to test whether or not the skills and knowledges learned in ARTACT transfer to AOBC classroom performance. Despite some interesting nonsignificant trends, the results of the analyses showed no differences between experimental and control groups. Although class performance measures possess obvious face validity, there are two problems with these criterion measures. One problem is that the AOBC measures, even those taken from the Armor Performance Test, measure some skills and knowledges that are not trained in ARTACT. To the extent that ARTACT skills and knowledges do not transfer to these additional skills, these academic measures would tend to underestimate the effects of ARTACT. The second problem is that the AOBC measures are academic achievement measures and, as such, may have psychometric characteristics that are not conducive to detecting group differences in performance. For instance, the differences in a few of the measures may have been obscured by ceiling effects as indicated by the high mean values seen in both groups. This criticism did not pertain to the percentile rank measure, however, whose means were close to the middle of the range (i.e., 50%). However, the latter measure represented overall AOBC performance, and was (along with class average) less relevant than results from the Armor Performance Test for measuring ARTACT skills and knowledges.

Software and Hardware Problems

Results from the analysis of the implementation problems revealed a variety of ARTACT software and hardware problems. Given that the present research represented the first implementation of ARTACT, the presence of program deficiencies was not unexpected. Identifying and correcting these deficiencies was a goal from the outset. Consequently, hardware and software changes were made during the study in an effort to improve the implementation of the programs. Nevertheless, since the Offensive Operations and Defensive Operations modules continued to freeze occasionally even at the end of the study, it is clear that the software and/or hardware deficiencies have not yet been completely corrected.

Since the programs could be not be tested and corrected prior to the research, it is important to take into account the possible impact the deficiencies could have on the assessment of their overall effectiveness. As noted in the Results, all of the programs except Planning FA Fires froze on occasion. When a program froze prior to the end, the program was restarted from the beginning providing students with additional training. Restarting

the program could have made the program appear more effective than it actually was. When a program froze at the end, the program was not restarted since the students had completed the module. However, these students could not receive a printout of their performance. While it is possible that the failure to receive a printout could have reduced the effectiveness of the program, the reduction in effectiveness should have been small since students received feedback during the program itself. Furthermore, it is possible that the other students who did receive a printout may never have examined it since the printout was given to each student at the end of a session. Unfortunately, no attempt was made to determine whether or not students used the printouts.

Subjective Reactions

In general, ARTACT had no effect on student perceptions of AOBC. The one exception to this generalization concerns their perceptions of the difficulty of AOBC topics that were related to the content of ARTACT. These topics were judged to be more difficult by the experimental group than by the control group. The two groups did not differ, however, in their judgments of the difficulty of AOBC topics that were unrelated to ARTACT. Since the experimental group showed greater gains than the control group in knowledges and skills covered in ARTACT, their perceptions of the difficulty of these topics appear inconsistent with their performance. One possible explanation for this somewhat paradoxical finding is that the additional training on ARTACT may have caused the students in the experimental group to be more cognizant of the complexity of the topics. Although this may be a reasonable explanation of the finding, it is clearly ad hoc and cannot be tested from the data obtained during the evaluation.

Reactions of students in the experimental group were generally favorable toward ARTACT becoming part of AOBC, but with qualifications for improvements they wanted. Student responses indicated that they had found ARTACT easy to use and that it had practical value as training to augment and better prepare them for their regular tactical training. Planning FA Fires was perceived as the most helpful program. This finding was unexpected since Planning FA Fires only partially overlaps the planning and identification of Target Reference Points (TRP) taught in planning platoon fires. However, equally surprising was the fact that no students perceived Defensive Operations to be the most helpful program. Defensive Operations was the last topic trained prior to the field exercise and compared to the other three programs, contained the least amount of new knowledge. Since the knowledges tutored in Planning FA Fires only partially overlap AOBC training, it is speculated that students judged the helpfulness of a program on the basis of the amount of new information it contained.

The presence of software and hardware problems were found to affect attitudes toward ARTACT, although the direction of the effect was unexpected. Compared to students who did not experience any software or hardware problems, students who had to restart a module rated ARTACT as more helpful as a way of learning about platoon tactics, more effective in getting them to think about platoon tactics, and easier to use. They also perceived the programs to be more interesting and bestowed more praise upon the research staff. The praise bestowed upon the research staff may have been the result of the effort that

was made by the staff to ensure that each student was provided an opportunity to complete each ARTACT program. The other attitudinal differences between the students who restarted a module and those who did not may be explained on the basis of cognitive dissonance (Festinger, 1957). The students who had to restart a program may have justified their efforts (i.e., reduced cognitive dissonance) by viewing ARTACT more favorably.

The results also showed that reactions to ARTACT were related to the students' success in training as indicated by their class rank in AOBC. The higher ranking students tended to view ARTACT as a useful supplement to AOBC, and their criticisms were focused more on improvements in feedback. They showed less of a tendency than the lower ranking students to be concerned with the reliability of the system. This finding suggests that the more successful students tended to react to ARTACT's most critical qualities, namely the training benefits that it could provide them. In contrast, the less successful students tended to react to ARTACT's superficial qualities, specifically those defects that could be easily corrected in subsequent versions.

Conclusions

In conclusion, the results of the evaluation indicated that ARTACT has merit as a method for helping students to learn tactical skills and knowledges in AOBC. This conclusion is further supported by the fact that students were generally positive in their reactions to the system. However, two cautionary points should also be mentioned. The first is that several software problems remain in the current system. These technical problems are potentially solvable by software engineers and do not invalidate ARTACT as a training system. The second point relates to the fact that, like most Army programs of instruction, AOBC is a fluid curriculum that changes as doctrine changes. Some changes have already caused discrepancies between ARTACT and AOBC instruction. For instance, a scenario within the ARTACT module on techniques of movement requires the student to recall the vee formation and indicate relative tank positions within the platoon. Students noted that this particular formation is no longer trained in AOBC. This sort of problem is more serious than software bugs in that it potentially threatens the relevancy of ARTACT instruction. In anticipation of these sorts of problems, Los Alamos National Laboratory developed an authoring system for changing ARTACT's scenario details, routes of movement, and targets for indirect fire. However, the authoring system's capabilities have not been formally tested to determine whether they can be readily used by training developers and whether they are sufficiently comprehensive to incorporate most doctrinal changes.

References

Alexander, P. A., & Judy, J. E. (1988). The interaction of domain-specific and strategic knowledge in academic performance. Review of Educational Research, 58, 375-404.

Anderson, J. R. (1981). Acquisition of cognitive skills. Psychological Review, 89, 369-406.

Barsalou, L. W. (1988). Intra-concept similarity and its implications for inter-concept similarity. In S. Vosniadou & A. Ortony (Eds.), Similarity and analogy. Cambridge: Cambridge University Press.

Bransford, J., Sherwood, R., Vye, N., & Rieser, J. (1986). Teaching thinking and problem solving: Research foundations. American Psychologist, 41, 1078-1089.

Bryant, J. A., Burris, K. R., Criscuolo, A., deVries, J. A., Emerson, J. D., Gallett, B., Knudsen, P. D., Long, S. J., McCarthy, T. J., McGrath, G. P., Osborn, M. M., Schultejann, P. A., Spangenburg, L., Trainor, M. S., & Andrews, A. E. (1987). The process of development of the second prototype of the combat unit leader trainer (A-6:87-Y-296). Los Alamos, NM: Los Alamos National Laboratory Military Systems Group.

Ericsson, K. A., & Simon, H. A. (1984). Protocol analysis: Verbal reports as data. Cambridge, MA: The MIT Press.

Festinger, L. (1957). A theory of cognitive dissonance. Evanston, IL: Row, Peterson.

Franks, J. J., Bransford, J. D., & Auble, P. M. (1982). The activation and utilization of knowledge. In, C. R. Puff (Ed.), Handbook of research methods in human memory and cognition (pp. 395-425). NY: Academic Press, Inc.

Glaser, R. (1984). Education and thinking: The role of knowledge. American Psychologist, 39, 93-104.

Kern, R. P., & Legree, P. (1988). CHALLENGE: An experimental computer program for research on organizing knowledge to improve retention and application (ARI Research Note 88-03). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences. (AD A190 629)

Lindquist, E. F. (1953). Design and analysis of experiments in psychology and education. Cambridge, MA: Houghton Mifflin Company.

Newell, A., & Simon, H. A. (1972). Human problem solving. Englewood Cliffs, NJ: Prentice-Hall.

Perkins, D. N., & Salomon, G. (1989). Are cognitive skills context-bound? Educational Researcher, 18, 16-25.

Stoddard, M. L., Kern, R. P., Emerson, J. (1986). A computer-based knowledge extraction tool: A step in the development of a cognitive skills tutor. Proceedings of the 27th International Conference of the Association for the Development of Computer-based Instructional Systems.

Wilkinson, L. (1986). SYSTAT: The system for statistics. Evanston, IL: Systat, Inc.

APPENDIX A

Questionnaires

A-1. Student Background Questionnaire

1. Name: _____
   Last First Middle Initial

2. Class Number: _____ 3. Roster Number: _____

4. SSN: _____ 5. Date of Birth: _____
   Day Month Year

6. Component:

   _____Active _____Reserve _____National Guard

7. Source of Commission:

   _____ROTC _____USMA _____OCS

   _____Other (Specify: _____)

8. Military Experience Prior to AOBC?

   _____No

   _____Yes (Describe below, including number of years)

_____

_____

_____

9. Computer Experience (check all that apply):

   _____Played computer games

   _____Used computer at school

   _____Used computer at work

   _____Used computer at home

   _____Studied computer science

   _____Wrote computer programs using a computer language (e.g., BASIC, FORTRAN, C)

   _____Other (Describe: _____)

PT-57-40

A-2. AOBC/ARTACT Questionnaire

Name:_____ Date:_____
Last First MI

Class Number:_____ Roster Number:_____

1. Rate the level of difficulty you experienced in understanding the following AOBC instruction. Use a scale of 1 to 100 where "1" is extremely easy and "100" is extremely difficult.

_____ Engineers and Mobility/Counter-Mobility Operations

_____ Call For and Adjust Indirect Fire

_____ Tactical Air Operations

_____ NBC Defensive Operations

_____ Command and Control

_____ Techniques of Movement

_____ Cavalry Operations

_____ Fundamentals of Reconnaissance

_____ Fundamentals of Security

_____ Fundamentals of Offense

_____ Fundamentals of Defense

2. How interesting was the AOBC classroom instruction on tactics?

Very Interesting	Quite Interesting	Somewhat Interesting	Slightly Interesting	Not Interesting At All

3. How prepared were you for applying tactical knowledge during the 10-day war?

Very Prepared	Quite Prepared	Somewhat Prepared	Slightly Prepared	Not Prepared At All

PT 57-40

4. In your opinion, how knowledgeable are you in planning and executing platoon tactics?

Very Knowledgeable	Quite Knowledgeable	Somewhat Knowledgeable	Slightly Knowledgeable	Not Knowledgeable At All

5. As a result of having participated in AOBC, how prepared are you to serve in combat as the leader of a tank platoon?

Very Prepared	Quite Prepared	Somewhat Prepared	Slightly Prepared	Not Prepared At All

6. How helpful were the ARTACT programs as a way of learning about platoon tactics?

Very Helpful	Quite Helpful	Somewhat Helpful	Slightly Helpful	Not Helpful At All

7. How hard was it to learn to use the computer to work on the ARTACT programs?

Not Hard At All	Slightly Hard	Somewhat Hard	Quite Hard	Very Hard

8. How interesting were the ARTACT programs?

Very Interesting	Quite Interesting	Somewhat Interesting	Slightly Interesting	Not Interesting At All

9. How effective were the ARTACT programs in getting you to think about platoon tactics?

Very Effective	Quite Effective	Somewhat Effective	Slightly Effective	Not Effective At All

10. Which ARTACT program did you find most helpful?

_____ Planning FA Fires
_____ Techniques of Movement
_____ Offensive Operations
_____ Defensive Operations

11. What do you <u>like</u> most about the ARTACT programs?

12. What do you <u>dislike</u> most about the ARTACT programs?

13. In your opinion should the ARTACT programs become part of the AOBC curriculum?

_____Yes

_____Yes, but only if they are improved (Answer question #14)

_____No

14. What improvements or changes should be made in the ARTACT programs?

15. Use this space to write any other comments or suggestions.

APPENDIX B

Comparisons of Experimental and Control Groups on Background and Experience Variables

Table B-1

Experience Reported by Experimental and Control Groups

Experience		Group: Experimental	Group: Control	Test Statistic	*p*
Military (In Years)	*M*	1.5	1.9	t (46) = 0.63	N.S.
	SD	2.3	1.8		
Reported Computer Experience in the Following Categories:					
Games	*f*	21	22	$(Chi)^2$ (1) = 0.58	N.S.
	%	84	81		
School	*f*	19	18	$(Chi)^2$ (1) = 0.55	N.S.
	%	76	67		
Work	*f*	15	7	$(Chi)^2$ (1) = 6.18	< .05
	%	60	26		
Home	*f*	12	6	$(Chi)^2$ (1) = 3.81	N.S.
	%	48	22		
Computer Science	*f*	11	9	$(Chi)^2$ (1) = 0.62	N.S.
	%	44	33		
Programming	*f*	14	10	$(Chi)^2$ (1) = 1.88	N.S.
	%	56	37		
"Other"	*f*	0	2		
	%	0	7		

Table B-2

Background of Experimental and Control Groups

Backgound		Group: Experimental	Group: Control	Test Statistic	*p*
Source of Commission					
ROTC	*f*	18	22	$(Chi)^2$ (1) = 0.66	N.S.
	%	72	81		
OCS	*f*	7	5		
	%	28	19		
Component					
Active Component	*f*	7	5	$(Chi)^2$ (2) = 1.21	N.S.
	%	28	19		
Army Reserves	*f*	6	5		
	%	24	19		
National Guard	*f*	12	17		
	%	48	63		

APPENDIX C

Tactical Knowledge Test Materials

C.1 Materials for Offensive Scenario

OPORD for the Offensive Scenario

1. SITUATION

a. Enemy Forces. Enemy elements of the 7th Motorized Rifle Div. have broken contact and have withdrawn to the south and are establishing hasty defensive positions vic Elizabethtown. The enemy has a Div. Security Zone consisting of a reinforced Motorized Rifle Bn in a Combat Security role. Ground and air recons have failed to locate any elements of the security zone, but we can expect to encounter individual OPs, with company hasty defensive positions 2 to 3 kms behind the OPs. The enemy is equipped with T-62s and BMPs. He is at 60% strength and has used chemical weapons within the last 48 hours.

b. Friendly Forces.

(1) TF 1-14 AR conducts a movement to contact to OBJ Gold at 0700 hours, 1 Jan 1990 to gain and maintain contact with withdrawal forces and to destroy any enemy combat security detachments in zone. On order, continue the attack to the south.

(2) Team C followed by Team B is on our right, to secure OBJs Mine and Rock.

(3) TF 1-81 INF is on our left, to secure OBJ Hawk.

(4) BN Scouts will conduct a zone reconnaissance with concentration on Axes Silver and Steel.

(5) 1-42 FA is in direct support. TF 1-14 has priority.

(6) Companies C and D are detached and the TF has received Co C, 1-81 INF.

(7) 3d PLT, Co A is detached and we have received 3d PLT (mech) Co C, 1-81 INF.

2. MISSION

Team A, TF 1-14 AR conducts a movement to contact along Axis Steel at 0700 hours to PL Brass to support by fire on OBJs Rock and Ore. On order, seize OBJ Ore. On order, continue the attack south.

3. EXECUTION

a. Concept of the Operation

(1) Manuever: As contact is possible south of LD Copper, the company will cross Copper in traveling overwatch in a company wedge; 1st PLT (Red) in the center, 3d PLT mech (Green) on the right, and 2nd PLT (White) on the left. If contact is made prior to PL Brass, the element making contact will fix the enemy and the remaining platoons will, on order, maneuver to destroy the enemy force. Upon arrival at PL Brass, 1st PLT occupy overwatch position vic CP 7 and orient on OBJ ORE. 2nd PLT occupy overwatch position vic CP 11 and orient on OBJ Rock. 3d PLT (mech), move to CP 9 and prepare to move to a dismount point at BC 2203, be prepared to sweep dismounted thru OBJ Ore. 1st and 2nd PLTs, on order, will assault OBJ Ore to CP 5 and 6 respectively. The company will consolidate on the OBJ with three PLTs abreast. On orders, continue the attack south.

(2) Fires:

(a) Arty for TM A is on request only.
(b) Smoke and DPICM are limited.
(c) Priority of fires initially to 1st PLT.
(d) All TRPs are registered pre-plots.
(e) Designated artillery targets as per your overlay.

b. Specific Instructions

(1) 1st Platoon (RED)

(a) Lead element in company wedge, moving along Axis Steel.
(b) Once contact is made, be prepared to become base of fire element.
(c) Be prepared to become an assault element.
(d) Upon securing CP on OBJ Ore, orient south between TRPs 104 and 105.

(2) 2nd Platoon (WHITE)

(a) Left element in company wedge, moving on Axis Steel.
(b) Once contact is made, be prepared to become base of fire element.
(c) Be prepared to become an assault element.

(d) Upon securing CP 6, orient south between TRPs 104 and 105.
(e) Do not bypass any enemy resistance.

(3) 3d Platoon (Mech) (GREEN)

(a) Right element in company wedge, moving on Axis Steel.
(b) Once contact is made, be prepared to become base of fire element.
(c) Be prepared to dismount INF to clear.
(d) On orders, move to CP 9 and prepare to assault BC 2203.
(e) Dismount INF clear OBJ Ore on order.
(f) Upon securing OBJ Ore, position your platoon vic BC 2203, orient south BC 2204.
(g) Do not bypass any enemy resistance.

c. Coordinating Instructions

(1) ADA status is weapons tight.
(2) MOPP Level 2 is in effect. Increase on orders or upon indirect fire.
(3) Be prepared to stop the enemy counterattack on OBJ Ore.
(4) Report all friendly graphics.

4. SERVICE SUPPORT: Per unit SOP.

Class I, III, and V on call thru 1SG.

5. COMMAND AND SIGNAL

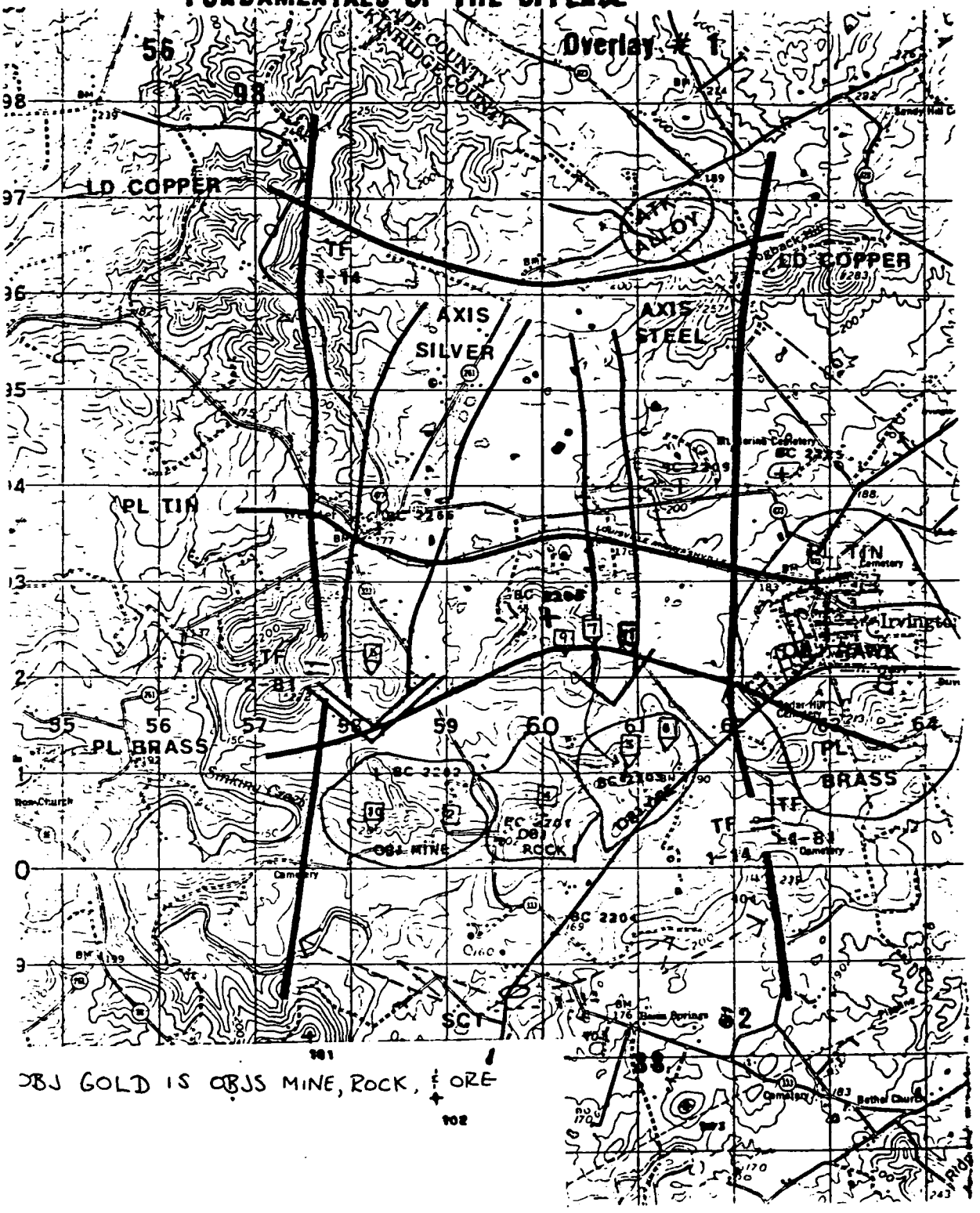
a. Signal

(1) CEOI Day 5 in effect.
(2) Standardized call signs are in effect.
(3) Arty Fire Direction Net call sign is BIGGUN ONE. Frequency is 38.15.
(4) Radio listening silence is in effect until LD Copper.

b. Command

(1) The succession of command is CO, XO, 1st, 2nd, 3d platoon leaders.
(2) The CO will be with 1st PLT initially.
(3) The XO will be with 3d PLT initially.

FUNDAMENTALS OF THE OFFENSE



OBJ GOLD IS OBJS MINE, ROCK, & ORE

Instructions for Administering the Offensive Tactical Exercise

The following instructions will be prerecorded. The experimenter should stop the tape recorder at (Pause) and restart at (Continue).

IN THE FOLLOWING EXERCISE, WE WILL TEST YOUR ABILITY TO PLAN AND EXECUTE A PLATOON OPERATION BY ASKING FOR YOUR RESPONSES TO SPECIFIC SITUATIONS. IN ADDITION TO YOUR RESPONSES, WE ARE INTERESTED IN YOUR THOUGHTS AS YOU APPROACH THESE SITUATIONS. IN ORDER TO DO THIS WE WILL ASK YOU TO TALK ALOUD AS YOU WORK ON THE PROBLEMS. WHAT WE MEAN BY TALK ALOUD IS THAT WE WANT YOU TO SAY OUT LOUD EVERYTHING THAT YOU MIGHT SAY OR THINK TO YOURSELF SILENTLY. IF YOU ARE SILENT FOR ANY LENGTH OF TIME I WILL REMIND YOU TO KEEP TALKING ALOUD. IF YOU DON'T UNDERSTAND THESE INSTRUCTIONS, PLEASE ASK THE EXPERIMENTER NOW.

(Pause)

Answer any questions before proceeding to first warm-up problem:

(Continue)

BEFORE WE TURN TO THE EXERCISE, WE WILL START WITH A PRACTICE PROBLEM. WE WANT YOU TO TALK ALOUD WHILE YOU DO THIS PROBLEM. WE WANT YOU TO RECALL THE FACTORS OF METT-T, WHICH ARE USED TO ANALYZE TACTICAL MISSIONS. IN OTHER WORDS, WE WANT YOU TO TALK ALOUD SO THAT YOU INDICATE WHAT YOU ARE THINKING WHILE YOU RECALL EACH FACTOR. GO AHEAD AND RECALL THE FACTORS OF METT-T.

(Pause)

Reinforce almost any response that approximates the correct answer (Mission, Enemy, Terrain, Weather, Troops, and Time) with an encouraging "GOOD"

Answer any question before continuing:

(Continue)

NOW THAT YOU UNDERSTAND THE INSTRUCTIONS TO TALK ALOUD, WE SHALL PROCEED WITH THE TACTICAL EXERCISE. REMEMBER, THAT THIS IS A TEST AND I WILL NOT BE ABLE TO PROVIDE ANY FEEDBACK ON THE CORRECTNESS OF YOUR RESPONSES. BE SURE THAT YOU CONTINUE TO TALK ALOUD AS YOU APPROACH THE PROBLEMS PRESENTED WITHIN THE FOLLOWING SCENARIO:

(Pause)

Answer any question before proceeding to the tactical exercise:

I. RECEIVE/ANALYZE MISSION

Present company level OPORD with appropriate overlays to student, and restart the prerecorded instructions.

(Continue)

IN THE FOLLOWING TACTICAL EXERCISES, YOU WILL ASSUME THE ROLE OF PLATOON LEADER OF 1ST PLATOON (RED) ATTACHED TO COMPANY TEAM A OF TASK FORCE 1ST OF THE 14TH ARMOR... IT IS NOW 0600 HOURS. YOU ARE IN ATTACK POSITION ALLOY AWAITING ORDERS TO CONDUCT A TACTICAL OPERATION. YOU MAY MAKE NOTES WHILE THE OPORD IS BEING READ, BUT ALL NOTES WILL BE COLLECTED AT THE END OF THE EXERCISE.

The OPORD is read aloud while the student reads a copy of the text. The student keeps his copy of the OPORD for reference throughout the exercise. He may make notes on the OPORD or on a separate piece of paper. Collect all notes at the end of the exercise. When the OPORD is finished, insert student tape and prepare to record responses. The instructor reads the remaining instructions.

In this phase, you will probe students for planning procedures. To the extent possible, let student describe his planning procedures naturally and in the order he wishes. However, if he does not provide a scheme of manuever by the time he is finished, probe him for that information using questions provided in Part D below. Start recording student responses and begin with the following instructions:

YOU ONLY HAVE ONE HOUR BEFORE MOVING TO THE LINE OF DEPARTURE. TELL WHAT PLANS YOU SHOULD MAKE OR ACTIONS YOU SHOULD TAKE TO PREPARE YOUR PLATOON FOR THIS MISSION. WHAT TASK SHOULD YOU START WITH? PLEASE REMEMBER TO TALK ALOUD AS YOU RESPOND.

(Troop Leading Procedures should include (a) receive and analyze mission, (b) issue warning order, (c) form tentative plan, (d) start necessary movement, (e) conduct reconnaissance, (f) make decisions/complete plan, (g) issue OPORD, and (h) supervise and refine.)

If the student does not know what troop leading procedures mean, you can define as "actions that a platoon leader takes prior to platoon operations."

React to most responses with a noncommittal: UH-HUH, WHAT ELSE? If the student responds "movement plan" or "manuever scheme," respond: THAT'S RIGHT, YOU WILL NEED TO PLAN A SCHEME OF MANUEVER. WHAT ASPECT OF THAT SCHEME DO YOU WANT TO PLAN FOR FIRST? If the student does not respond with manuever scheme before finishing with troop leading procedures, you will need to prompt: ONE ASPECT OF PLANNING THAT YOU WILL NEED TO PROVIDE IS A SCHEME OF MANUEVER. WHAT ASPECT OF THAT SCHEME DO YOU WISH TO PLAN FOR FIRST?

Student may do the following elements of the manuever scheme in any order. But he must complete all three aspects before going on to other aspects of planning. In other words, if the student does not provide this information, the experimenter will have to elicit it.

A. Select route. OK, USE A PENCIL TO DRAW YOUR CHOICE OF ROUTE ON THE MAP.

(Drawn route should (a) start at Attack Position Alloy, (b) use SR 261 north of LD Copper, (c) stay within Axis Steele, (d) bypass hills to avoid skylining, (e) connect with Checkpoint 7, and (f) terminate at Objective Ore.)

If the other aspects of manuever have not been covered, say: WHAT OTHER ASPECTS OF MANUEVER DO YOU NEED TO PLAN FOR?

B. Movement technique/formation. WHAT MOVEMENT TECHNIQUES WOULD YOU USE ALONG THAT ROUTE? If the student does not break the route into two parts, you will have to systematically ask the following questions:

1. Move from attack position to line of departure. Break up this question into separate questions concerning movement technique and movement formation.

   a. OK, WHAT MOVEMENT TECHNIQUE WOULD YOU USE TO MOVE FROM THE ATTACK POSITION TO THE LINE OF DEPARTURE?

      If the student does not say or describe the traveling technique, read the following statement: THE DOCTRINAL CHOICE FOR THIS SITUATION IS THE TRAVELING TECHNIQUE.

   b. WHAT MOVEMENT FORMATION WOULD YOU USE TO REACH THE LINE OF DEPARTURE?

      If the student does not say or describe the column formation, read the following statement: THE DOCTRINAL CHOICE FOR THIS SITUATION IS THE COLUMN FORMATION.

2. Move from line of departure to overwatch position. Break up this question into separate questions concerning movement technique and movement formation.

   a. WHAT MOVEMENT TECHNIQUE WOULD YOU USE ONCE YOU HAVE PASSED THE LINE OF DEPARTURE?

      If the student does not say or describe the traveling technique, read the following statement: THE DOCTRINAL CHOICE FOR THIS SITUATION IS THE TRAVELING TECHNIQUE.

b. WHAT MOVEMENT FORMATION WOULD YOU USE TO REACH THE OVERWATCH POINT?

If the student does not say or describe the wedge formation, read the following statement: THE DOCTRINAL CHOICE FOR THIS SITUATION IS THE WEDGE FORMATION.

II. MOVE TO PL BRASS--SURPRISE EVENTS

Before platoon reaches Phase Line Brass, two surprise events occur. Ask the following questions, but do not indicate the correct answer.

A. Small Arms Fire--Out of Sector

AS YOUR PLATOON MOVES ACROSS PHASE LINE TIN, YOU RECEIVE 80-100 ROUNDS OF SMALL ARMS FIRE FROM A POINT ON STATE ROAD 477, JUST SOUTH OF BRAVO CHARLIE 2225. HOW SHOULD YOU REACT? (Provide contact report and proceed.)

B. Direct Fire from Objective Ore

YOU APPROACHED PHASE LINE BRASS AND RECEIVE YOUR ORDER TO MOVE INTO POSITION AT CHECK POINT 7. ONCE IN POSITION, YOU RECEIVE DIRECT FIRE FROM IDENTIFIABLE ENEMY TANKS ON OBJECTIVE ORE. HOW SHOULD YOU REACT? (Engage targets and provide contact report.)

III. HASTY DEFENSE AT PL BRASS

YOUR PLATOON IS STILL IN POSITION AT CHECK POINT 7, AND YOU RECEIVE THE FOLLOWING FRAGO:

RED 1, WHITE 1, GREEN 1, THIS IS ONE. PRELIMINARY REPORTS FROM BATTALION SCOUTS INDICATE TWO POSSIBLE COMPANY-SIZE ENEMY ARMOR UNITS EQUIPPED WITH T-62s LOCATED ON OBJECTIVE ORE. COUNTERATTACK IMMINENT. IMMEDIATELY PREPARE HASTY DEFENSE OF PRESENT POSITIONS. PLAN INDIRECT FIRE TARGET LOCATIONS IN FRONT OF YOUR POSITIONS AND REPORT TARGET NOMINATIONS TO FSO. OVER.

WHAT SHOULD YOUR FIRST REACTION BE TO THIS MESSAGE? (Authenticate.)

AS INDICATED BY THE FRAGO, YOU WILL NEED TO PLAN TARGET LOCATIONS.

A. Target locations. Place the sheet showing target location symbols in subject's view and say: INDICATE TARGET LOCATIONS BY DRAWING THE SYMBOL FOR EITHER CONVENTIONAL, LINE, OR AREA TARGETS AS APPROPRIATE ON YOUR MAP.

(At least one target should be located (a) on top of battle position, (b) in front of battle position, (c) behind battle position, (d) on avenues of approach, (e) on prominent terrain features, (f) easily identifiable features, (g) outside range of direct fire weapons, and (h) outside of artificial boundaries.)

B. Shell/fuze combinations. Once they have finished locating indirect fire target locations, say: NUMBER THE TARGETS CONSECUTIVELY AND INDICATE APPROPRIATE SHELL/FUZE COMBINATIONS BY LISTING EACH TARGET ON THIS SHEET WITH THE CORRESPONDING ACCRONYMS AS LISTED AT THE BOTTOM OF THE SHEET. (Not scored.)

IV. ASSAULT OF OBJ ORE

THE ENEMY DOES COUNTERATTACK BUT SUFFERS HEAVY LOSSES. YOU RECEIVE ANOTHER MESSAGE FROM THE COMPANY COMMANDER TO CONTINUE THE MISSION TO SECURE CHECK POINTS 5 AND 6 AND BE PREPARED TO ASSAULT BRAVO CHARLIE 2203.

A. Movement. If student has not already done so, have him plan the movement from CP 7 to CP 5, including

1. Select route. USE A PENCIL TO INDICATE ON THE MAP YOUR CHOICE OF ROUTE FROM YOUR PRESENT POSITION TO THE OBJECTIVE.

   If the other aspects of manuever have not been covered, say: WHAT OTHER ASPECTS OF MANUEVER DO YOU NEED TO PLAN FOR?

2. Movement formation. WHAT MOVEMENT FORMATION WOULD YOU USE TO REACH THE OBJECTIVE?

   If the student does not say or describe the line formation, read the following statement: THE DOCTRINAL CHOICE FOR THIS SITUATION IS THE LINE FORMATION.

B. Surprise Event--Indirect Fire.

AS YOU APPROACH THE OBJECTIVE, ARTILLERY BEGINS BURSTING ALL AROUND YOU. IT APPEARS TO BE HIGH EXPLOSIVES MIXED WITH SMOKE. WHAT SHOULD YOU DO? (Don masks, button up, go faster.)

V. CONCLUSION

YOU SURVIVE THE INDIRECT FIRE ATTACK AND YOU HAVE SECURED THE OBJECTIVE. THE PLATOON REPORTS A WINGMAN TANK THAT HAS SUFFERED ONE WOUNDED IN ACTION REQUIRING EVACUATION. THE PLATOON HAS EXPENDED 30 SABOT ROUNDS, 12 HEAT ROUNDS, 3000 COAX ROUNDS, 500 CAL .50 ROUNDS, AND 1000 GALLONS DIESEL. WHAT ACTION SHOULD YOU TAKE? (Send a SITREP (Blue-2).)

VI. ADDITIONAL QUESTIONS

A. Draw Formations.

1. Column.

EARLIER IN THE SCENARIO WE DISCUSSED THE COLUMN FORMATION. PLEASE DRAW THE COLUMN FORMATION INDICATING THE POSITIONS OF ALL FOUR TANKS AND THEIR GUN TUBE ORIENTATIONS.

2. Wedge.

DO THE SAME THING FOR THE WEDGE FORMATION.

3. Line.

DO THE SAME THING FOR THE LINE FORMATION.

B. Hand-and-arm signals. Present hand and arm signals with letters identifying each. Ask for the signals by letter for the following techniques or formations:

1. Hand and arm signal for traveling technique.

2. Hand and arm signal for column formation.

3. Hand and arm signal for the wedge formation.

4. Hand and arm signal for the line formation.

C-2. Materials for Defensive Scenario

OPORD for the Defensive Scenario

1. SITUATION

   a. Enemy Forces. We can expect elements of the 143rd Motorized Rifle Division to attack our defensive positions with a reinforced Motorized Rifle Brigade, with two Motorized Rifle Companies leading, one following. The S-2 indicated that the Brigade is at 90% strength and are equipped with T-62s, BMPs, and BRDMs. The enemy has used nonpersistent chemical agents in the last 24 hours.

   b. Friendly Forces.

      (1) TF 1-14 defends in sector NLT H-HR, on order CATK to complete the destruction of the enemy.

      (2) Bn Sct PLT is presently conducting screening operations, in front of the TF, vic the 98 E-W grid line, and on order they will shift to a subsequent screen on the east flank of the TF.

      (3) TM B is defending BP 75 NLT H-HR on our left flank, and on order will displace to BP 33.

      (4) TM C is defending BP 41 NLT H-HR on our right flank, and on order will displace to BP 57.

      (5) TM D is defending BP 82 NLT H-HR, and on order will displace to BP 25.

      (5) 1-40 FA is in direct support of the Brigade.

   c. Attachments/Detachments. We have the 3/C/2-87 Mech attached.

2. MISSION

   TM A defends BP 62 NLT H-HR. On order, displace to BP 28. On order, counterattack to complete enemy destruction.

3. EXECUTION

   a. Concept of the Operation

(1) Manuever: TM A will conduct a deliberate occupation of BP 62 to be established NLT H-HR, oriented on EA Eagle. The Bn Scout PLT will provide early warning of the enemy's attack, and on order, they will shift to the east flank of the TF. Engage targets outside EA eagle with indirect fire only. Engage targets inside EA Eagle with direct fires only. The trigger point will be when a company-sized element enters EA Eagle. The breakpoint will be when four or more enemy vehicles breach or bypass the minefield in EA eagle. If the enemy main attack is from our east flank, we will shift to supplementary BPs or displace and conduct a hasty occupation of BP 28. On order, I will issue a FRAGO to counterattack and re-establish BP 62.

(2) Fires: Priority of fires within the team will go to 1st PLT. All TRPs are also registered artillery preplots. Platoon leaders be prepared to plan defensive indirect targets as required. Submit indirect fire target nominations to company FSO.

(3) Obstacles: Engineer support has already completed all obstacles. See overlay.

(4) Specific instructions: See execution matrix.

(5) Coordinating instructions: MOPP Level 2 is now in effect. Upgrade on order or upon receiving indirect fire.

4. SERVICE AND SUPPORT: By unit SOP.

5. COMMAND AND SIGNAL

a. Command.

(1) I will be with 2nd PLT.

(2) XO will be with the 3rd PLT.

(3) Succession of command: XO, 1st, 2nd, 3rd, and MECH PLT leaders.

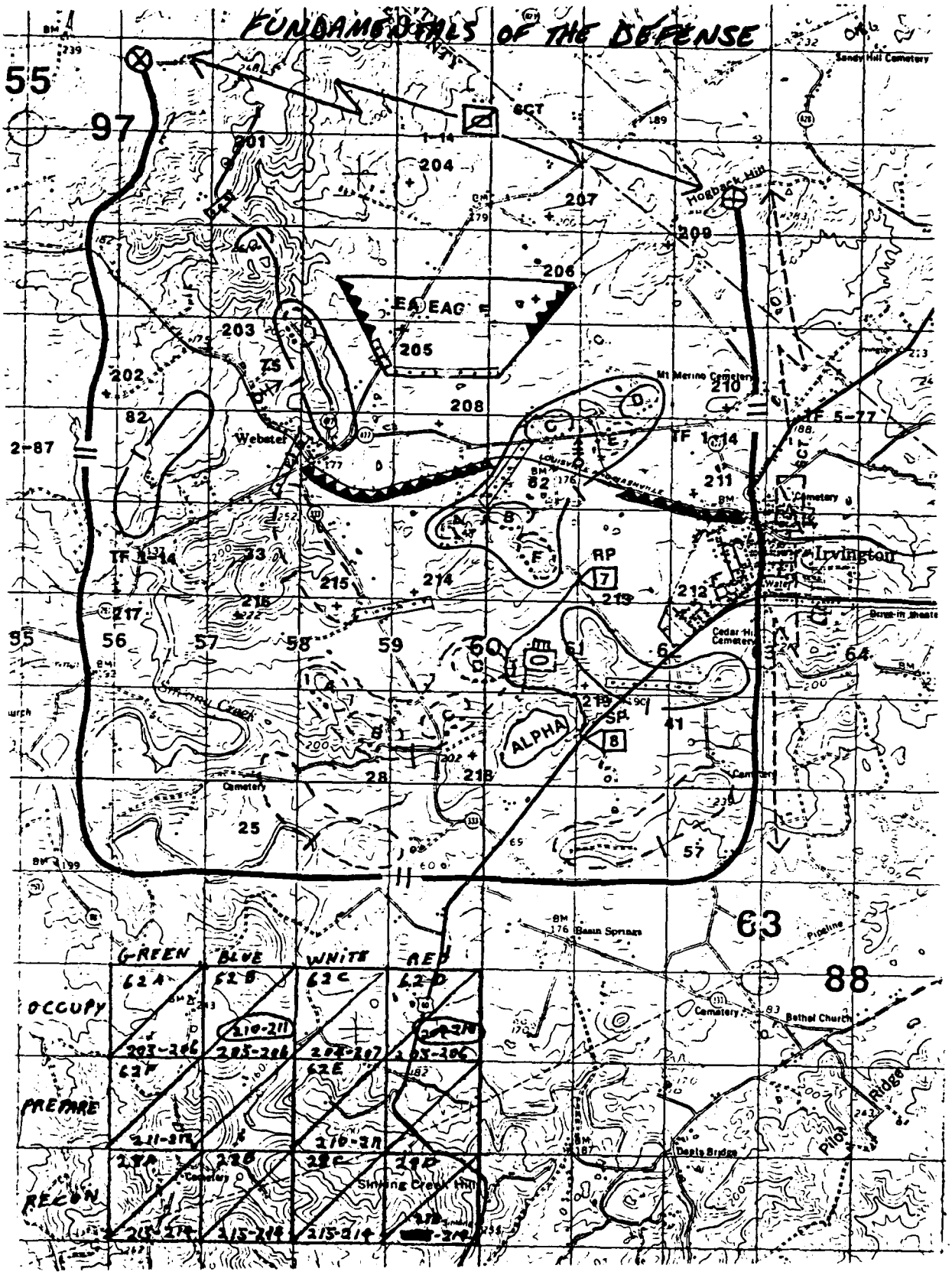
b. Signal.

(1) Day 5 of the CEOI is in effect.

(2) 1st PLT call sign is Red-1.

(3) 2nd PLT call sign is White-1.

(4) 3rd PLT call sign is Blue-1.


FUNDAMENTALS OF THE DEFENSE
55
97
95
2-87
Webster
Irvington
Mt Merino Cemetery
Sandy Hill Cemetery
Hogback Hill
Cedar Hill Cemetery
Sinking Creek
ALPHA
Basin Springs
Bethel Church
Pilot Ridge
Pipeline
Dogie Bridge
GREEN
BLUE
WHITE
RED
OCCUPY
PREPARE
RECON
62A
62B
62C
62D
62E
62F
63
88

(5) Mech PLT call sign is Green-1.

(6) TM CDR call sign is per CEOI.

(7) FIST call sign is Black 1.

(8) Artillery Fire Direction Net Call sign is X72, frequency 31.25.

Instructions for Administering the Defensive Tactical Exercise

The following instructions will be prerecorded. The experimenter should stop the tape recorder at (Pause) and restart at (Continue).

IN THE FOLLOWING EXERCISE, WE WILL TEST YOUR ABILITY TO PLAN AND EXECUTE A PLATOON OPERATION BY ASKING FOR YOUR RESPONSES TO SPECIFIC SITUATIONS. IN ADDITION TO YOUR RESPONSES, WE ARE INTERESTED IN YOUR THOUGHTS AS YOU APPROACH THESE SITUATIONS. IN ORDER TO DO THIS WE WILL ASK YOU TO TALK ALOUD AS YOU WORK ON THE PROBLEMS. WHAT WE MEAN BY TALK ALOUD IS THAT WE WANT YOU TO SAY OUT LOUD EVERYTHING THAT YOU MIGHT SAY OR THINK TO YOURSELF SILENTLY. IF YOU ARE SILENT FOR ANY LENGTH OF TIME I WILL REMIND YOU TO KEEP TALKING ALOUD. IF YOU DON'T UNDERSTAND THESE INSTRUCTIONS, PLEASE ASK THE EXPERIMENTER NOW.

(Pause)

Answer any questions before proceeding to first warm-up problem:

(Continue)

BEFORE WE TURN TO THE EXERCISE, WE WILL START WITH A PRACTICE PROBLEM. WE WANT YOU TO TALK ALOUD WHILE YOU DO THIS PROBLEM. WE WANT YOU TO RECALL THE FACTORS OF METT-T, WHICH ARE USED TO ANALYZE TACTICAL MISSIONS. IN OTHER WORDS, WE WANT YOU TO TALK ALOUD SO THAT YOU INDICATE WHAT YOU ARE THINKING WHILE YOU RECALL EACH FACTOR. GO AHEAD AND RECALL THE FACTORS OF METT-T.

(Pause)

Reinforce almost any response that approximates the correct answer (Mission, Enemy, Terrain, Weather, Troops, and Time) with an encouraging "GOOD"

Answer any question before continuing:

(Continue)

NOW THAT YOU UNDERSTAND THE INSTRUCTIONS TO TALK ALOUD, WE SHALL PROCEED WITH THE TACTICAL EXERCISE. REMEMBER, THAT THIS IS A TEST AND I WILL NOT BE ABLE TO PROVIDE ANY FEEDBACK ON THE CORRECTNESS OF YOUR RESPONSES. BE SURE THAT YOU CONTINUE TO TALK ALOUD AS YOU APPROACH THE PROBLEMS PRESENTED WITHIN THE FOLLOWING SCENARIO:

(Pause)

Answer any question before proceeding to the tactical exercise:

I. RECEIVE/ANALYZE MISSION

Present company level OPORD with appropriate overlays to student, and restart the prerecorded instructions.

(Continue)

IN THE FOLLOWING TACTICAL EXERCISES, YOU WILL ASSUME THE ROLE OF PLATOON LEADER OF 1ST PLATOON (RED) ATTACHED TO COMPANY TEAM A OF TASK FORCE 1ST OF THE 14TH ARMOR... IT IS NOW 0600 HOURS WITH H-HOUR SET FOR 0700. YOU ARE IN ASSEMBLY AREA ALPHA AWAITING ORDERS TO CONDUCT A TACTICAL OPERATION. YOU MAY MAKE NOTES WHILE THE OPORD IS BEING READ, BUT ALL NOTES WILL BE COLLECTED AT THE END OF THE EXERCISE.

The OPORD is read aloud while the student reads a copy of the text. The student keeps his copy of the OPORD for reference throughout the exercise. He may make notes on the OPORD or on a separate piece of paper. Collect all notes at the end of the exercise. When the OPORD is finished, insert student tape and prepare to record responses. The instructor reads the remaining instructions.

In this phase, you will probe students for planning procedures. To the extent possible, let student describe his planning procedures naturally and in the order he wishes. However, if he does not provide a scheme of manuever by the time he is finished, probe him for that information using questions provided in Part D below. Start recording student responses and begin with the following instructions:

YOU ONLY HAVE ONE HOUR BEFORE MOVING TO YOUR BATTLE POSITION. TELL WHAT PLANS YOU SHOULD MAKE OR ACTIONS YOU SHOULD TAKE TO PREPARE YOUR PLATOON FOR THIS MISSION. WHAT TASK SHOULD YOU START WITH? PLEASE REMEMBER TO TALK ALOUD AS YOU RESPOND.

(Troop Leading Procedures should include (a) receive and analyze mission, (b) issue warning order, (c) form tentative plan, (d) start necessary movement, (e) conduct reconnaissance, (f) make decisions/complete plan, (g) issue OPORD, and (h) supervise and refine.)

II. MOVE TO BATTLE POSITION 62 DELTA

If the student has not spontaneously provided a manuever scheme before finishing describing his plans, you will need to prompt: ONE ASPECT OF PLANNING THAT YOU WILL NEED TO PROVIDE IS A SCHEME OF MANUEVER. WHAT ASPECT OF THAT SCHEME DO YOU WISH TO PLAN FOR FIRST?

Student may do the following elements of the manuever scheme in any order. But he must complete all three aspects before going on to other aspects of planning. In other words, if the student does not provide this information, the experimenter will have to elicit it.

A. Select route. OK, USE A PENCIL TO DRAW YOUR CHOICE OF ROUTE ON THE MAP.

If the other aspects of manuever have not been covered, say: WHAT OTHER ASPECTS OF MANUEVER DO YOU NEED TO PLAN FOR?

(Drawn route should (a) start at Assembly Area Alpha, (b) use indicated route between Checkpoints 7 and 8, (c) avoid planned barricades and minefields, (d) bypass hills to avoid skylining, and (e) terminate at BP 62D.)

B. Movement technique/formation. WHAT MOVEMENT TECHNIQUES WOULD YOU USE ALONG THAT ROUTE? If the student does not break the route into two parts, you will have to systematically ask the following questions:

1. Move from Assembly Area Alpha to the battle position. Break up this question into separate questions concerning movement technique and movement formation.

   a. OK, WHAT MOVEMENT TECHNIQUE WOULD YOU USE TO MOVE FROM THE ASSEMBLY AREA TO THE BATTLE POSITION?

      If the student does not say or describe the traveling technique, read the following statement: THE DOCTRINAL CHOICE FOR THIS SITUATION IS THE TRAVELING TECHNIQUE.

   b. WHAT MOVEMENT FORMATION WOULD YOU USE WHILE ON THIS ROUTE?

      If the student does not say or describe the column formation, read the following statement: THE DOCTRINAL CHOICE FOR THIS SITUATION IS THE COLUMN FORMATION.

2. At battle position. If the student has not provided a stop formation as part of his plan, ask the following:

   OK, WHAT MOVEMENT FORMATION WOULD YOU USE ONCE YOU HAVE REACHED THE BATTLE POSITION?

If the student does not say or describe the coil formation, read the following statement: THE DOCTRINAL CHOICE FOR THIS SITUATION IS THE COIL FORMATION.

III. PLAN INDIRECT FIRE TARGET LOCATIONS AT BATTLE POSITION 62 DELTA

If the student has not already planned indirect fires, have him do so now.

AS INDICATED IN THE OPERATIONS ORDER, YOU NEED TO BE PREPARED TO NOMINATE INDIRECT FIRE TARGET LOCATIONS.

A. Target locations. Place the sheet showing target location symbols in subject's view and say: INDICATE TARGET LOCATIONS BY DRAWING THE SYMBOL FOR EITHER CONVENTIONAL, LINE, OR AREA TARGETS AS APPROPRIATE ON YOUR MAP. (Not scored.)

B. Shell/fuze combinations. Once they have finished locating indirect fire target locations, say: NUMBER THE TARGETS CONSECUTIVELY AND INDICATE APPROPRIATE SHELL/FUZE COMBINATIONS BY LISTING EACH TARGET ON THIS SHEET WITH THE CORRESPONDING ACRONYMS AS LISTED AT THE BOTTOM OF THE SHEET.

(At least one target should be located (a) on top of battle position, (b) in front of battle position, (c) behind battle position, (d) on avenues of approach, (e) on prominent terrain features, (f) easily identifiable features, (g) outside range of direct fire weapons, and (h) outside of artificial boundaries.)

IV. TARGET ON STATE ROAD 261

A. Tanks outside of Engagement Area Eagle. YOU HAVE SPOTTED AN IDENTIFIABLE ENEMY TANK PLATOON ON STATE ROAD 261 IN THE VICINITY OF GRID LOCATION 607965 (point). WHAT ACTION SHOULD YOU TAKE? (Call for indirect fire North .3 of TRP 207)

B. Possible HIND-D. THE ENEMY ATTACK HAS BEEN TEMPORARILY SLOWED, BUT IN THE MEAN TIME, YOU SPOT A HIND-D ON THE HORIZON. HE EVIDENTLY HAS NOT SEEN YOU OR YOUR PLATOON. WHAT ACTION SHOULD YOU TAKE? (Go into hide position and provide report.)

C. Tanks within Engagement Area Eagle. THE ENEMY CONTINUES TO ADVANCE IN LARGER NUMBERS. YOU SPOT A COMPANY-SIZED ENEMY ARMOR UNIT ON STATE ROAD 261 IN THE VICINITY OF GRID 592952 (point). WHAT ACTION SHOULD YOU TAKE? (Issue platoon fire command/engage targets with direct fire.)

V. HASTY OCCUPATION OF BATTLE POSITION 28

A. Move from Battle Position 62 Delta. TWO COMPANY-SIZED ARMOR UNITS ARE NOW IN ENGAGEMENT AREA EAGLE AND HAVE STARTED TO BYPASS MINEFIELD AND HEAD TOWARD YOUR POSITION. THE COMPANY COMMANDER ISSUES A FRAGO TO MOVE QUICKLY TO BATTLE POSITION 28 AND BEWARE OF ENEMY IN ZONE. WHAT IS YOUR SCHEME OF MANUEVER FOR GETTING THERE?

As before, provide the following prompts only if needed.

1. Select route. Provide red pencil and prompt:

INDICATE YOUR CHOICE OF ROUTE FROM YOUR PRESENT BATTLE POSITION TO THE SUPPLEMENTARY BATTLE POSITION USING THIS PENCIL.

(Route should (a) go behind BPs 62 and 28, and (b) terminate at BP 28C.

2. Select movement technique. OK, WHAT MOVEMENT TECHNIQUE WOULD YOU USE TO MOVE TO THE SUPPLEMENTARY BATTLE POSITION?

If the student does not say or describe the traveling overwatch technique, read the following statement: THE DOCTRINAL CHOICE FOR THIS SITUATION IS TRAVELING OVERWATCH.

3. Select movement formation. WHAT MOVEMENT FORMATION WOULD YOU USE WHILE ON THIS ROUTE?

If the student does not say or describe the column formation, read the following statement: THE DOCTRINAL CHOICE FOR THIS SITUATION IS THE COLUMN FORMATION.

B. Sagger Missile from Right Flank. AS YOUR PLATOON MOVES TO BATTLE POSITION 28, A BMP ADVANCES AROUND BATTLE POSITION 62 DELTA AND FIRES A SAGGER MISSILE AT YOUR PLATOON. WHAT IS YOUR ACTION? (Alert platoon, conduct evasive action drill and report.)

C. FRAGO. YOU RECEIVE THE FOLLOWING FRAGO OVER THE RADIO:

RED-1, THIS IS ONE. WHITE HAS ATTRITTED TO 25% STRENGTH. OCCUPY BATTLE POSITION 28 CHARLIE. CONSOLIDATE WHITE PLATOON'S FIRES WITH YOURS. ORIENT BETWEEN TRPs 215 to 219. OVER.

WHAT IS YOUR FIRST REACTION TO THIS MESSAGE? (Authenticate.)

VI. SURPRISE EVENT--INDIRECT FIRE

AS YOU APPROACH THE OBJECTIVE, ARTILLERY BEGINS BURSTING ALL AROUND YOU. IT APPEARS TO BE HIGH EXPLOSIVES MIXED WITH SMOKE. WHAT SHOULD YOU DO? (Don masks, button up, go faster.)

VII. CONCLUSION

ONCE ON BATTLE POSITION 28 CHARLIE, THE COMPANY IS ATTACKED FROM THE DIRECTION OF BATTLE POSITION 62. YOUR PLATOON SUCCESSFULLY DEFENDS THE SUPPLEMENTARY POSITION BUT SUFFERS MOBILITY KILLS TO TWO TANKS AND TWO WOUNDED IN ACTION, BOTH REQUIRING EVACUATION. YOUR PLATOON SERGEANT REPORTS THAT YOU'VE EXPENDED 50 ROUNDS OF SABOT, 13 ROUNDS OF HEAT, 2000 COAX ROUNDS, 200 ROUNDS OF CAL .50 AMMUNITION, AND 1200 GALLONS OF FUEL. WHAT ACTION SHOULD YOU TAKE? (Send SITREP (Blue-2).)

VIII. ADDITIONAL QUESTIONS

A. Draw Formations.

1. Column.

EARLIER IN THE SCENARIO WE DISCUSSED THE COLUMN FORMATION. PLEASE DRAW THE COLUMN FORMATION INDICATING THE POSITIONS OF ALL FOUR TANKS AND THEIR GUN TUBE ORIENTATIONS.

2. Coil.

DO THE SAME THING FOR THE COIL FORMATION.

B. Hand-and-arm signals. Present hand and arm signals with letters identifying each. Ask for the signals by letter for the following techniques or formations:

1. Hand and arm signal for traveling technique.

2. Hand and arm signal for traveling overwatch technique.

3. Hand and arm signal for the column formation.

4. Hand and arm signal for the coil formation.

APPENDIX D

Intercorrelations Among Tactical Knowledge Measures

Table D-1

Intercorrelations Among Knowledge Variables for Both Experimental and Control Groups (N = 51)

Where Measured	Pretest				Armor Performance Test		Posttest			
Variable	1	2	3	4	5	6	7	8	9	10
Pretest										
1. Knowledge Test	1.000	-0.405**	-0.394**	-0.287*	-0.081	-0.303*	0.153	-0.272	-0.378**	0.326*
2. SK Incidental Verbalizations		1.000	0.293*	0.103	0.123	0.121	-0.072	0.323*	0.329*	-0.108
3. GH Incidental Verbalizations			1.000	0.175	-0.165	0.139	-0.163	0.375**	0.472**	0.019
4. Use of Schemata				1.000	0.043	-0.065	-0.075	0.153	0.132	0.237
Armor Performance Test										
5. Performance Component					1.000	0.269	-0.137	0.238	-0.052	-0.100
6. Written Component						1.000	-0.252	0.256	0.132	-0.152
Posttest										
7. Knowledge Test							1.000	-0.229	-0.265	0.094
8. SK Incidental Verbalizations								1.000	0.261	-0.125
9. GH Incidental Verbalizations									1.000	-0.333*
10. Use of Schemata										1.000

Note. Knowledge Test score is the average error rate computed for the test objectives. SK and GH Incidental Verbalizations refer to comments made by students on the knowledge test indicating the use of specific knowledge and general heuristics, respectively. Use of Schemata is a binary variable indicating whether or not students used doctrinally recognized schemata to organize their responses to the CHALLENGE program.

*$p < .05$
**$p < .01$

Table D-2

Intercorrelations Among Knowledge Variables for Experimental Group (N = 25)

Where Measured / Variable	Pretest 1	2	3	4	Armor Performance Test 5	6	Posttest 7	8	9	10
Pretest										
1. Knowledge Test	1.000	-0.316	-0.573**	-0.247	0.096	-0.361	0.150	-0.472*	-0.463*	0.250
2. SK Incidental Verbalizations		1.000	0.286	0.209	0.114	0.108	-0.169	0.184	0.545**	0.175
3. GH Incidental Verbalizations			1.000	0.119	-0.138	0.240	-0.058	0.443**	0.712**	0.062
4. Use of Schemata				1.000	0.055	0.008	0.015	0.238	0.121	0.327
Armor Performance Test										
5. *Performance Component*					1.000	0.344	-0.117	0.064	-0.304	0.122
6. Written Component						1.000	-0.148	0.300	0.224	-0.146
Posttest										
7. Knowledge Test							1.000	-0.255	-0.056	-0.230
8. SK Incidental Verbalizations								1.000	0.348	-0.154
9. GH Incidental Verbalizations									1.000	-0.047
10. Use of Schemata										1.000

Note. Knowledge Test score is the average error rate for the test objectives. SK and GH Incidental Verbalizations refer to comments made by students on the knowledge test indicating the use of specific knowledge and general heuristics, respectively. Use of Schemata is a binary variable indicating whether or not students used doctrinally recognized schemata to organize their responses to the CHALLENGE program.

*$p < .05$
**$p < .01$

Table D-3

Intercorrelations Among Knowledge Variables for Control Group (N = 26)

Where Measured	Pretest				Armor Performance Test		Posttest			
Variable	1	2	3	4	5	6	7	8	9	10
Pretest										
1. Knowledge Test	1.000	-0.423*	-0.193	-0.280	-0.350	-0.256	0.299	-0.111	-0.345	0.329
2. SK Incidental Verbalizations		1.000	0.373	-0.038	0.210	0.149	-0.134	0.443*	0.211	-0.219
3. GH Incidental Verbalizations			1.000	0.298	-0.240	-0.047	-0.282	0.321	0.281	-0.051
4. Use of Schemata				1.000	0.077	-0.149	-0.208	0.086	0.143	0.243
Armor Performance Test										
5. Performance Component					1.000	0.181	-0.091	0.400*	0.132	-0.341
6. Written Component						1.000	-0.374	0.218	0.059	-0.175
Posttest										
7. Knowledge Test							1.000	-0.232	-0.381	0.362
8. SK Incidental Verbalizations								1.000	0.209	-0.112
9. GH Incidental Verbalizations									1.000	-0.501**
10. Use of Schemata										1.000

Note. Knowledge Test score is the average error rate for all test objectives. SK and GH Incidental Verbalizations refer to comments made by students on the knowledge test indicating the use of specific knowledge and general heuristics, respectively. Use of Schemata is a binary variable indicating whether or not students used doctrinally recognized schemata to organize their responses to the CHALLENGE program.

*$p < .05$
**$p < .01$

APPENDIX E

Analysis of Variance Summary Tables

Table E-1

Summary of Analysis of Errors on Tactical Test

Source	ANOVA *df*	ANOVA *MS*	ANOVA *F*	MANOVA *df*	MANOVA *Lambda*	MANOVA *F*
Group (GRP)	1	0.00	0.00			
Order (ORD)	1	0.12	1.64			
GRP X ORD	1	0.18	2.46			
$Error_b$	47	0.08				
Test Objective (OBJ)	6	0.65	16.00***	6, 42	0.32	14.66***
GRP X OBJ	6	0.08	1.87	6, 42	0.76	2.25
ORD X OBJ	6	0.09	2.20	6, 42	0.76	2.18
GRP X ORD X OBJ	6	0.05	1.18	6, 42	0.85	1.24
$Error_w$	282	0.04				
Trials (TRL)	1	123.91	344.34***			
GRP X TRL	1	2.94	8.16**			
ORD X TRL	1	0.12	0.34			
GRP X ORD X TRL	1	0.36	0.10			
$Error_w$	47	0.04				
OBJ X TRL	6	0.74	18.83***	6, 42	0.28	18.36***
GRP X OBJ X TRL	6	0.04	0.88	6, 42	0.89	0.86
ORD X OBJ X TRL	6	0.23	5.84***	6, 42	0.55	5.72***
GRP X ORD X OBJ X TRL	6	0.04	1.10	6, 42	0.85	1.25
$Error_w$	282	0.04				

* $p < .05$
** $p < .01$
*** $p < .001$

Table E-2

Summary of Analyses of Student Comments Related to Different Levels of Knowledge

Source	*df*	*MS*	*F*
		Specific Knowledge	
Group (GRP)	1	5.144	0.75
$Error_b$	49	33.711	
Trials (TRL)	1	14.486	4.08*
GRP X TRL	1	5.074	1.43
$Error_w$	49	17.377	
		General Heuristics	
Group (GRP)	1	0.473	0.05
$Error_b$	49	9.060	
Trials (TRL)	1	15.785	4.37*
GRP X TRL	1	0.451	0.12
$Error_w$	49	3.609	
		Intermediate Level	
Group (GRP)	1	0.015	0.03
$Error_b$	49	0.527	
Trials (TRL)	1	0.157	0.28
GRP X TRL	1	0.000	0.00
$Error_w$	49	0.568	

*$p < .05$
**$p < .01$

Table E-3

Summary of Analysis of Confidence on Challenge

Source	*df*	*MS*	*F*
Group (GRP)	1	1216.30	4.69*
$Error_b$	49	259.16	
Trials (TRL)	1	2150.28	14.32**
GRP X TRL	1	148.71	0.99
$Error_w$	49	150.13	

*$p < .05$
**$p < .01$
***$p < .001$

Table E-4

Summary of Analysis of Schemata Usage

Source	*df*	*MS*	*F*
		Presence of Schemata	
Group (GRP)	1	0.02	0.06
$Error_b$	50	0.27	
Trials (TRL)	1	2.87	17.60***
GRP X TRL	1	0.56	3.46
$Error_w$	50	0.16	
		Number of Instances of Schemata Usage	
Group (GRP)	1	0.38	0.52
$Error_b$	50	0.73	
Trials (TRL)	1	5.90	11.00**
GRP X TRL	1	1.52	2.84
$Error_w$	50	0.54	

*$p < .05$
**$p < .01$
***$p < .001$

Table E-5

Summary of Analyses of Overall AOBC Measures

Source	*df*	*MS*	*F*
		Class Average	
Group (GRP)	1	23.96	2.72
$Error_b$	56	4.82	
		Percentile Rank	
Group (GRP)	1	2888.28	3.89
$Error_b$	56	742.36	

$^{*}p < .05$
$^{**}p < .01$
$^{***}p < .001$

Table E-6

Summary of Analysis of Differences Between Written and Performance Components of the Armor Performance Test

Source	*df*	*MS*	*F*
Group (GRP)	1	435.31	1.63
$Error_b$	56	266.96	
Component (CO)	1	568.02	3.66
GRP X CO	1	125.12	0.81
$Error_w$	56	154.85	

$^{*}p < .05$
$^{**}p < .01$
$^{***}p < .001$

Table E-7

Summary of Analysis of Differences Between Objectives Within Written and Performance Components of the Armor Performance Test

Source	ANOVA			MANOVA		
	df	*MS*	*F*	*df*	*Lambda*	*F*
Written Component						
Group (GRP)	3	207.89	0.45			
$Error_b$	56	458.56				
Objective (OBJ)	1	16.27	0.04			
GRP X OBJ	1	54.25	0.13			
$Error_w$	56	419.33				
Performance Component						
Group (GRP)	1	2115.08	1.67			
$Error_b$	56	1267.19				
Objective (OBJ)	3	1713.70	2.08	3, 54	0.90	2.04
GRP X OBJ	3	329.09	0.40	3, 54	0.98	0.38
$Error_w$	56	823.56				

$^{*}p < .05$
$^{**}p < .01$
$^{***}p < .001$

Table E-8

Summary of Analysis of Difficulty Ratings of AOBC Topics

Source	ANOVA *df*	ANOVA *MS*	ANOVA *F*	MANOVA *df*	MANOVA *Lambda*	MANOVA *F*
Group (GRP)	1	2933.05	0.69			
$Error_b$	38	4277.09				
Topic (TOP)	10	3416.66	7.96**	10, 29	0.31	6.42**
Related TOP (REL)	5	1436.56	5.46**	5, 34	0.56	5.37**
Unrelated TOP (UNR)	4	6685.12	12.58**	4, 35	0.43	11.69**
REL vs. UNR (R/U)	1	243.38	0.29			
GRP X TOP	10	783.05	1.82	10, 29	0.62	1.76
GRP X REL	5	404.92	1.54	5, 34	0.88	0.90
GRP X UNR	4	579.76	1.09	4, 52	0.85	1.54
GRP X R/U	1	3486.81	4.10*			
$Error_w$	380	428.98				
$Error_{w1}$	190	262.84				
$Error_{w2}$	152	531.49				
$Error_{w3}$	38	849.66				

*$p < .05$
**$p < .01$
***$p < .001$

Table E-9

Summary of Analysis of Differences Between Items Relating to AOBC

Source	ANOVA			MANOVA		
	df	*MS*	*F*	*df*	*Lambda*	*F*
Group (GRP)	1	0.70	0.78			
$Error_b$	38	0.90				
Question (QSN)	3	0.21	0.54	3, 36	0.95	0.69
GRP X QSN	3	0.10	0.26	3, 36	0.97	0.41
$Error_w$	114	0.38				

$^{*}p < .05$
$^{**}p < .01$
$^{***}p < .001$

Table E-10

Summary of Analysis of Items Relating to ARTACT as a Function of Problems Experienced During the Training Sessions

Source	ANOVA			MANOVA		
	df	*MS*	*F*	*df*	*Lambda*	*F*
Problems (Y/N)	1	15.68	4.43*			
$Error_b$	23	3.54				
Question (QSN)	3	5.66	8.01***	3, 21	0.55	5.71**
Y/N X QSN	3	0.16	0.22	3, 21	0.95	0.38
$Error_w$	69	0.71				

*$p < .05$
**$p < .01$
***$p < .001$

APPENDIX F

Content Analysis of Incidental Verbalizations

The instructions to talk aloud while answering questions on the tactical knowledge test were relatively successful in evoking verbalizations that were incidental in that they were above and beyond their direct answers to questions. The student transcripts were examined to reveal commonalities among these verbal data. This content analysis indicated that 10 different types of verbalizations were given by at least two students on either the prestest or the posttest. Most of the verbalizations provided at least a partial rationale for the students' answers. However, other types of verbalizations were noted as well. Each type of comment is defined below with verbatim examples taken from student transcripts. The mean frequency of occurrence for each type of verbalization is displayed in Table E-1.

1. In explaining the reason for a response, students often said it was dictated by a specific characteristic of the situation or the action itself. This sort of comment often is in the form of an "if-then" rule, which does not make sense to those who are not knowledgeable in tactics.

   - o "We'd be moving in traveling, since I'm being overwatched."
   - o "If he can cover my move with another platoon, then I can use the fastest means possible to get to my other battle position, which would be traveling...If he can't cover my move, I'd have to bound in section."

2. Another reason for a particular action (or nonaction) was that the student wanted to achieve some desirable outcome or avoid a nondesirable one. This reasoning appears to be based on common sense or deduction that should make more sense to those who are less knowledgeable in tactics.

   - o "I don't want to fire at it. It's almost impossible for a tank to hit one of those vehicles..."
   - o "I would probably want ONE to authenticate (to) make sure that it's not bogus information.

3. Students sometimes provided a statement of some relevant general principle(s) that potentially guides responses to tactical scenario, but is not tied to any particular answer within a scenario.

   - o "...I'd want to designate the technique of movement and a formation. That would be based on likely enemy contact."
   - o "Definitely need to use cover and concealed routes. Stay way from the built-up areas. Stay out of open areas."

4. Instead of telling us why he did something, the student sometimes spontaneously told us <u>how</u> he does something. (Does not count initial planning where he was specifically asked how to plan for an operation.)

   - o "I would then give my platoon a platoon fire command...I would give them AT MY COMMAND. What I would say would be RED, THIS IS RED ONE, TANK DIRECT FRONT, CROSS AT MY COMMAND, OUT."

   - o "I could do a deliberate (occupation) in an hour. First thing we would do is stop in back of Battle Position D on the back side of this hill in a coil...."

5. Students sometimes reported that they responded on the basis of anticipated <u>enemy actions</u>.

   - o "First of all, I'd put (an indirect fire target location) here...It's a good place for the enemy to get good location.

   - o "I'd probably want to put (a target location) right on top of them. And I would assume they're ... on the hilltop."

6. Student sometimes explicitly stated that information in the orders (<u>OPORD or FRAGO</u>) was the reason for a specific response.

   - o "(The) OP order says we'd be the base of fire, so I'd give a contact to my platoon, give them an action drill, and begin firing on whoever is firing on us."

   - o "It looks like he's expecting the attack from the east, because that's the only one he mentioned in the OP order...I'd go with that (indirect fire target location)."

7. If the student explicitly indicated that the reason for a particular response was his <u>interpretation of the mission</u>, his comment fell in this category.

   - o "We're the defense, but we're the hasty defense right now, but we're still going down, so I don't want to drop anything that won't explode on catact, so I'll probably go with the HE (shell/fuze combination)."

   - o "...if there was time, I might call some indirect fire down on battle position 62. But our objective there is get to our subsequent battle position, so I would (just) return fire."

8. Students sometimes commented that their responses were based on <u>doctrine or SOP</u> or other rote tactical rules without further elaboration.

- "What I'd do first is first thing give a contact report. SOP."
- (What movement formation would you use along this route?) "Doctrine indicates column."

9. Students sometimes based their responses on a personal preference.
   - "There may be too many (indirect fire target locations), but I like to overemphasize artillery."
   - "I like to stay on the left (side of the wedge formation). I think the doctrine is stay on the right, but I'm left-handed. So I'd usually have my tank on the left side."

10. Not often students provided a mnemonic or imaginal aid that they use to remember the correct response to a question.
   - (What is the hand/arm signal for the traveling overwatch technique?) "The bird. The bird is K."
   - "The column is basically waving your hand in front of your face like waving to a parade."

Table F-1

Mean Number of Verbalizations by Category

Type of Comments	Group	As Measured At Pretest	As Measured At Posttest
Specific Characteristic	Experimental	3.08	4.12
	Control	3.81	4.08
Anticipated Outcome	Experimental	3.40	2.72
	Control	2.96	2.69
General Principles	Experimental	0.60	1.08
	Control	1.27	0.88
Interpretation of OPORD/FRAGO	Experimental	0.64	0.80
	Control	0.81	0.85
Enemy Actions	Experimental	0.60	0.36
	Control	0.77	0.38
"How-To" Information	Experimental	0.16	0.60
	Control	0.04	1.23
Required by Mission	Experimental	0.28	0.28
	Control	0.23	0.08

(table continues)

Type of Comments	Group	As Measured At Pretest	As Measured At Posttest
Dictated by Doctrine/SOP	Experimental	0.04	0.12
	Control	0.12	0.35
Personal Preference	Experimental	0.08	0.08
	Control	0.04	0.31
Mnemonic/Imaginal Coding	Experimental	0.04	0.16
	Control	0.15	0.08

APPENDIX G

Additional Analyses of Unstructured Questionnaire Items

Introduction

Responses to the four open-ended questionnaire items were discussed briefly in the Results section of this report. A more detailed description of the responses and breakdowns by uncontrolled events and student characteristics are presented below.

Description of Responses

Most liked aspects. The responses made to the question asking students what they liked most about the ARTACT programs are shown in Table G-1. A total of 35 responses were given to the question, and only two students did not answer it. The responses were sorted into clusters with six clusters emerging. The largest cluster, which contained ten responses (made by nine students), consisted of statements praising ARTACT's role in helping to prepare for AOBC classes. The students claimed, for example, that ARTACT helped them to prepare for the field exercise or that it provided them an opportunity to practice their skills. The next largest cluster, which contained eight responses (made by five students), praised specific characteristics of the ARTACT programs. The students stated, for example, that all of the subjects came together in ARTACT or that the graphics were interesting. Another cluster, which contained seven responses (made by six students), focused on feedback, e.g., the comment that they were able to participate in the exercise and then receive feedback on their performance. The remaining clusters focused on the specific information that was learned (e.g., hand-and-arm signals, field artillery), remarked on the competence of the research staff, or contained miscellaneous comments.

Most disliked aspects. The responses made to the question asking students what they disliked most about the ARTACT programs are shown in Table G-2. A total of 46 responses were given to the question, and only two students failed to answer it. The responses were sorted with seven clusters emerging. The largest cluster, which contained ten responses (made by six students), consisted of statements that were critical of the ARTACT training schedule. The students claimed, for example, that the ARTACT programs took up their free time, took time away from training, and were not coordinated with their AOB classes. Two clusters contained nine responses. One of these pertained to criticisms of specific aspects of the program (made by six students). One student, for example, stated that the programs were redundant at times, while another did not like the emphasis on formations and movement techniques. One student claimed that ARTACT required an existing knowledge of tactics, while another felt that the program moved ahead even when the student was not ready. The other cluster containing nine responses (made by eight students) criticized ARTACT for deviating from doctrine. Other clusters contained responses criticizing the rigidity with which ARTACT accepted

answers (e.g., the claim that only certain phrases were accepted by the computer or the observation that answers could not be changed), the quality of the map display, and the equipment problems that occurred during the evaluation. The final cluster consisted of three miscellaneous responses.

Recommended improvements. The responses made to the question asking what improvements or changes should be made in ARTACT are shown in Table G-3. A total of 46 responses were given to the question, although three students did not answer it. Nine clusters emerged when the responses were sorted. The largest cluster, which contained ten responses (made by six students), contained recommendations concerning the characteristics of the programs. Recommendations were made, for example, that the programs be more flexible in accepting answers, that deviations from doctrine be allowed, and that the amount of instructional detail be increased. The next largest cluster, which consisted of seven responses (made by six students), contained recommendations that the software and hardware be improved. The remaining clusters focused on the map display (including the recommendation that paper maps be used), feedback (including the recommendation that an evaluator be present to discuss each student's performance), scenarios and missions, consistency with classroom instruction and doctrine, uses for ARTACT (e.g., to teach offensive and defensive missions, to teach the basics), and scheduling (e.g., the recommendation that ARTACT be available during classroom hours). Finally, one additional cluster contained two miscellaneous responses.

Comments and suggestions. The responses made to the question asking students to write any other comments or suggestions are shown in Table G-4. A total of 32 responses were made to the item, although 11 students did not respond to it. Four clusters emerged when the responses were sorted. The largest cluster, which contained 13 responses (made by five students), contained a diversity of critical comments. Among them were the suggestions that a programmed text be used instead of ARTACT and that ARTACT not become part of the AOBC curriculum. One response was simply the statement that ARTACT training was disappointing. On the other hand, there was a cluster of five responses (made by four students) that were complimentary. Among them were the statements that the programs were enjoyable, that all AOBC students should participate on ARTACT, and that ARTACT provided an outstanding learning experience. Another cluster contained eight miscellaneous suggestions (made by seven students) including the suggestion that the student be "killed" when making a drastic mistake, that tactics instructors examine the programs, and that the AOBC students who use the M60 tank train on ARTACT while the other AOBC students train on U-COFT. The final cluster contained six responses (made by four students) that praised the research staff.

Correlations with Uncontrolled Events or Student Characteristics

Analyses were performed to determine if the responses to the four open-ended questions correlated with the hardware and software problems that many of the students experienced (as indicated by having to restart at least one of the four ARTACT modules) or with the students' success in AOBC (as indicated by rank in AOBC class and amount of improvement on the tactical knowledge test). To perform these analyses, the first step was to identify the

characteristics of the students who made each response to each question. Every response was categorized according to whether or not the student who made it experienced a hardware/software problem, was in the top or bottom half of his AOBC class, and was above or below the median in improvement on the tactical knowledge test. The number of students within each category who made each response are shown in Tables G-1 through G-4. The next step was to count the number of students who made at least one response within each response cluster. This information is also shown in Tables G-1 through G-4. To determine if the responses correlated to each of the three student characteristics, a set of 2 x 2 tables was created. Each table contained cross-tabulations based on characteristics of the students and the responses made within a cluster. That is, the number of students making at least one response within a cluster and the number of students not making at least one response were determined for students with the characteristic being examined and again for those without it. Since the numbers of students responding within individual clusters was small, Fisher's Exact Tests were conducted to determine whether or not the correlations between student characteristics and questionnaire responses were significant. The results are summarized below.

Correlations with hardware/software problems. Having a hardware or software problem did not correlate significantly with responses to the items asking students what they liked most about the ARTACT programs, what they disliked most about the programs, or what improvements or changes should be made in the ARTACT programs. However, experiencing a hardware or software problem did relate significantly to comments on ARTACT staffmembers made on the questionnaire item asking students to write other comments or suggestions. Four of the ten students who experienced a software or hardware problem praised the research staff compared to none of the fifteen students who did not experience such a problem, $p = .017$. There was also a greater trend for the students who experienced a problem to respond to this item, although the trend was not statistically significant: Two of the 10 students experiencing a hardware/software problem failed to respond to this question, while 9 of the 15 students who did not experience a problem failed to respond, $p = .099$.

Correlations with class rank in AOBC. Rank in AOBC correlated significantly with responses made on just one of the four open-ended questions: On the item asking what improvements or changes should be made in the ARTACT programs, four of the thirteen students in the top half of their class recommended changes or improvements in feedback compared to none of the twelve students in the bottom half of their class, $p = .039$. Two other correlations with class rank approached statistical significance: (a) On the same questionnaire item, just one student in the top half of his class recommended the use of more reliable software or hardware compared to five students in the bottom half of their class, $p = .073$; and (b) on the questionnaire item asking students what they liked most about the ARTACT programs, seven students in the top half of their class cited ARTACT's role in helping them to prepare for AOBC compared to just two students in the bottom half, $p = .097$.

Correlations with improvement in tactical knowledge test scores. Amount of improvement from the pretest to the posttest on the tactical knowledge test correlated only with responses to the question asking students what

improvements or changes should be made in the ARTACT program. Four of the twelve students whose improvement in tactical knowledge was below the median recommended improvements in the ARTACT's map display while none of the thirteen students whose improvement was above the median made this suggestion, $p = .039$. There was also a nonsignificant trend for students in the lower half of knowledge improvement to propose additional uses for ARTACT, $p = .096$.

Table G-1

Number of Responses to ARTACT Questionnaire Item Asking Students What They Liked Most About ARTACT Programs (Presented by Response Cluster and Event/Student Characteristic)

Response Cluster What Student Liked Most	Total Number of Responses	Event/Student Characteristic: Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
Preparation for AOBC Classes							
Provided preparation for armor exam and field problem	1	1		1		1	
Program was helpful during the 10-day war	1	1			1	1	
Provided additional instruction	1	1			1		1
Provided a chance to practice skills	1	1			1		1
Provided preparation for AOB instruction	1	1		1			1
Provided exposure to platoon operations before classroom instruction	1		1	1		1	
Using tactics training before 10-day war	1	1		1			1
Provided preparation for later classes	1	1		1			1
Programs complement their counterparts	1	1		1			1
Helpful addition to classroom instruction	1		1	1			1
(Number of Students Responding to Cluster)	(9)	(7)	(2)	(7)	(2)	(3)	(6)

(table continues)

Response Cluster What Student Liked Most	Total Number of Responses	Event/Student Characteristic					
		Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
Program Characteristic							
Interesting graphics and video	1		1	1			1
Great graphics	1		1		1	1	
All subjects interact	1		1	1			1
All subjects come together in one format	1		1	1			1
Programs building upon themselves	1	1		1			1
Realism involved in learning tactical operations (OPORDS, maps, FRAGOs)	1		1	1		1	
Casualty rate in program is optimistic	1		1		1	1	
Interesting scenarios	1		1		1	1	
(Number of Students Responding to Cluster)	(5)	(1)	(4)	(4)	(1)	(2)	(3)

(table continues)

Response Cluster What Student Liked Most	Total Number of Responses	Event/Student Characteristic: Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
Feedback							
Going through the exercise alone	1		1		1	1	
Getting immediate feedback	2		2	1	1	1	1
Seeing what I know and do not know	1		1		1	1	
Learning by running a mission and being given the solution	1	1			1	1	
Getting to plan offense and defense, and seeing the mistakes	1		1		1	1	
Applying knowledge and getting instant feedback	1	1		1		1	
(Number of Students Responding to Cluster)	(6)	(2)	(4)	(2)	(4)	(5)	(1)

(table continues)

Response Cluster What Student Liked Most	Total Number of Responses	Event/Student Characteristic: Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
Information Learned							
Hand-and-arm signals, techniques of movement, troop leading procedures	1		1	1			1
Field artillery	1	1			1	1	
Introduction to planning and offense	1	1			1		1
Primer for tactics	1	1				1	1
(Number of Students Responding to Cluster)	(4)	(3)	(1)	(2)	(2)	(2)	(2)
Research Personnel							
Mr. Foster	1	1			1		1
Competent people running ARTACT program	1		1	1			1
Very good staff	1		1		1	1	
(Number of Students Responding to Cluster)	(3)	(1)	(2)	(1)	(2)	(1)	(2)
Miscellaneous							
Better than terrain boards	1	1			1	1	
Good location	1		1	1			1
Getting to the end	1	1		1	1		
(Number of Students Responding to Cluster)	(3)	(2)	(1)	(1)	(2)	(2)	(1)
No Comments							
(Number of Students)	(2)	(1)	(1)	(1)	(1)	(0)	(2)

Table G-2

Number of Responses to ARTACT Questionnaire Item Asking Students What They Most Disliked About ARTACT Programs (Presented by Response Cluster and Event/Student Characteristic)

Response Cluster / What Student Disliked Most	Total Number of Responses	Event/Student Characteristic: Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
Scheduling							
ARTACT program came before classroom instruction	1	1			1		1
Equipment problems made schedule inconvenient	2	2		1	1	1	1
Not coordinated with AOB classes	1	1			1	1	
Uses up free time	2	2			2	1	1
Had to wait at least 30 minutes before starting	1	1			1	1	
Instruction took too much time away from training	1		1	1			1
ARTACT should be conducted during training hours	1		1		1	1	
ARTACT schedule conflicted with school	1		1		1	1	
(Number of Students Responding to Cluster)	(6)	(4)	(2)	(2)	(4)	(3)	(3)

(table continues)

Response Cluster What Student Disliked Most	Total Number of Responses	Event/Student Characteristic: Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
Differences from Doctrine							
Programs presented definite solutions; some were wrong	1		1		1		1
Did not agree with solutions pertaining to "techniques of movement"	1		1		1	1	
The requirements presented for good route selection contradicted the school solution that was presented	1	1		1			1
There were contradictions within the programs	1	1		1			1
Programs frequently differed from classroom instruction	3	2	1	1	2	2	1
Mismatch between doctrine and school	1		1	1		1	
Programs did not show the school way or field way	1	1			1	1	
(Number of Students Responding to Cluster)	(8)	(5)	(3)	(4)	(4)	(4)	(4)

(table continues)

Response Cluster What Student Disliked Most	Total Number of Responses	Event/Student Characteristic: Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
Specific Aspects of the Program							
The beginning of the program with the Colonel	1		1		1	1	
Showing the Captain	1		1		1	1	
Showing the movement of the tracks	1		1		1	1	
Too much concentration on formations movement techniques	1	1		1			1
ARTACT assumed knowledge of tactics	1	1		1			1
Program moved ahead even when the student was not ready	1		1	1		1	
Evaluation matrix was nonsensical	1	1			1		1
Programs were redundant at times	1	1		1			1
Did not point out better choices and show why	1	1		1			1
(Number of Students Responding to Cluster)	(6)	(4)	(2)	(4)	(2)	(2)	(4)

(table continues)

Response Cluster What Student Disliked Most	Total Number of Responses	Event/Student Characteristic: Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
Rigidity of Programs							
Program was rigid--had to match school solution	2	2		1	1		2
Program was more rigid than instructors	1	1		1			1
Could not vary from route selected by school	1		1		1	1	
The constraints on movement were slightly rigid	1		1	1			1
Computer accepted only certain phrases	1	1		1			1
Program looks for key words	1		1		1	1	
Program was rigid--couldn't change answers	1	1			1		1
(Number of Students Responding to Cluster)	(7)	(5)	(2)	(4)	(3)	(2)	(5)
Quality of Map Display							
Pictures of terrain were confusing	1		1	1			1
Map graphics were poor	1	1			1	1	
Map was impossible to read	1	1	1		2		2
(Number of Students Responding to Cluster)	(4)	(2)	(2)	(1)	(3)	(1)	(3)

(table continues)

Response Cluster What Student Disliked Most	Total Number of Responses	Event/Student Characteristic: Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
Equipment Problems							
Bugs were not all worked out	1		1	1		1	
Computer went down	2	2			2	2	
(Number of Students Responding to Cluster)	(3)	(2)	(1)	(1)	(2)	(3)	(0)
Miscellaneous							
No substitute for the field	1	1			1	1	
Not applicable	1	1			1	1	
Nothing	1		1		1	1	
(Number of Students Responding to Cluster)	(3)	(2)	(1)	(0)	(3)	(3)	(0)
No response							
(Number of Students)	(2)	(0)	(2)	(2)	(0)	(0)	(2)

Table G-3

Number of Responses to ARTACT Questionnaire Item Asking What Improvements Should be Made in ARTACT (Presented by Response Cluster and Event/Student Characteristic)

Response Cluster / Improvements	Total Number of Responses	Event/Student Characteristic: Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
Programs Characteristics							
Expand the vocabulary	1	1		1		1	1
Do not show the movement techniques	1		1	1	1		1
Work more on offensive and defensive tactics	1	1		1		1	1
Make it more challenging	1	1		1		1	1
Increase the amount of detail in the instruction	1		1	1	1		1
Allow deviations from doctrine	1	1		1		1	1
Make the programs more interactive	1		1	1	1		1
Revise the programs so that they do not assume prior knowledge	1		1	1	1		1
Increase the flexibility of the programs in terms of accepting answers	2	1	1	1	1	1	1
(Number of Students Responding to Cluster)	(6)	(3)	(3)	(5)	(1)	(2)	(4)

(table continues)

Response Cluster / Improvements	Total Number of Responses	Event/Student Characteristic: Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
Software/Hardware							
Use more reliable equipment	4	2	2	1	3	1	3
Get a new program	1	1			1		1
Software needs revision	1	1			1		1
Make programs more user friendly so I/O is not needed	1	1			1	1	
(Number of Students Responding to Cluster)	(6)	(4)	(2)	(1)	(5)	(2)	(4)
Map Display							
Improve graphics, maps	3	1	2	2	1		3
Use paper maps with legible graphics	1	1			1		1
Use real overlays	1	1			1		1
(Number of Students Responding to Cluster)	(4)	(2)	(2)	(2)	(2)	(0)	(4)

(table continues)

Response Cluster / Improvements	Total Number of Responses	Event/Student Characteristic: Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
Feedback							
Provide more detail (e.g., more detailed AAR) when pointing out mistakes	1	1		1		1	
Provide prompts that will not give away answers	1		1	1		1	
Have somebody familiar with school doctrine present to discuss answers	1	1		1			1
Add more human evaluation that points out better decisions	1	1		1			1
Prompts should be timely rather than at end	1		1	1		1	
(Number of Students Responding to Cluster)	(4)	(3)	(1)	(4)	(0)	(2)	(2)
Scenarios and Missions							
Focus training on one continuous mission with FRAGOs	1	1		1			1
Need more combat scenarios	2		2		2	2	
Need realistic situations, including casualties	1		1		1	1	
New situations should be presented after feedback is given	1		1	1			1
(Number of Students Responding to Cluster)	(4)	(1)	(3)	(2)	(2)	(2)	(2)

(table continues)

Response Cluster / Improvements	Total Number of Responses	Event/Student Characteristic: Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
Uses for ARTACT							
Use it to teach offensive and defensive missions	1	1			1		1
Use it to teach all the basics (hand and arm signals, movement techniques)	1	1			1		1
Should be able to practice all facets of artillery use until skills are mastered	1	1			1		1
Should increase its availability	1	1		1			1
Use to supplement tactics instruction prior to 10-day war	1		1	1			1
(Number of Students Responding to Cluster)	(3)	(2)	(1)	(2)	(1)	(0)	(3)
Consistency with Classroom, Doctrine							
Make the programs more in line with current curriculum	1	1			1		1
Make sure the programs are doctrinally correct	1	1		1			1
Do not require gun tube to be to the rear when the tank is the lead element in a company column formation	1		1		1	1	
Make the programs more in line with classroom instruction	1	1		1		1	
(Number of Students Responding to Cluster)	(4)	(3)	(1)	(2)	(2)	(2)	(2)

(table continues)

Response Cluster / Improvements	Total Number of Responses	Event/Student Characteristic: Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
Scheduling							
Schedule the programs so that the topics are presented after they are covered in the classroom	1		1	1			1
Should be set up during class hours	2	1	1		2	2	
(Number of Students Responding to Cluster)	(3)	(1)	(2)	(1)	(2)	(2)	(1)
Miscellaneous							
Use the ARTACT programs with terrain boards	1	1		1			1
Drop it	1	1			1	1	
(Number of Students Responding to Cluster)	(2)	(2)	(0)	(1)	(1)	(1)	(1)
No Responses							
(Number of Students)	(3)	(2)	(1)	(1)	(2)	(3)	(0)

Table G-4

Number of Responses to ARTACT Questionnaire Item Asking Students to Write Comments and Suggestions (Presented by Response Cluster and Event/Student Characteristic)

Response Cluster / Comment or Suggestion	Total Number of Responses	Event/Student Characteristic: Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
Negative Comments							
Training was disappointing	1		1		1		1
Ignored good judgment for school solution	1		1		1		1
Tactics and leadership cannot always have a correct answer	1		1		1		1
No purpose to the program	1	1			1		1
Learned more from terrain boards	1	1			1		1
Programs not synchronized with AOB instruction	1	1			1		1
ARTACT is rigid and primitive	1	1			1		1
Get rid of the program and the civilians who wrote it	1	1			1	1	
ARTACT should not be part of AOBC curriculum	1	1		1			1
Spend more time in the field on real tanks	1	1			1		1
Live tactics in AOBC more interesting and better than ARTACT	1	1		1			1
Programmed text would be better and cheaper	1	1		1			1
ARTACT is a technology looking for a reason to exist	1	1		1			1
(Number of Students Responding to Cluster)	(5)	(4)	(1)	(1)	(4)	(1)	(4)

(table continues)

Response Cluster / Comment or Suggestion	Total Number of Responses	Event/Student Characteristic: Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
Suggestions							
Should teach how to analyze mission and initiate action	1		1		1		1
Use for M60 students while AOB students are on COFT	1	1			1	1	
Kill the user if he makes a drastic mistake	1		1	1			1
Schedule ARTACT on week nights	1		1	1		1	
Use ARTACT to teach skills and terrain boards to restore skills	1	1			1		1
Have Tactics Branch (MTT) representative review ARTACT programs	1	1			1	1	
Have tactics instructors scrutinize program	1		1	1			1
Should be allowed to go back after mistakes have been identified	1		1		1	1	
(Number of Students Responding to Cluster)	(7)	(3)	(4)	(2)	(5)	(4)	(3)

(table continues)

Response Cluster Comment or Suggestion	Total Number of Responses	Event/Student Characteristic: Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
Comments on ARTACT Staffmembers							
ARTACT staffmembers are flexible and hardworking	1		1	1			1
Staff was superb	1		1		1	1	
Fort Knox personnel are trying to build a quality product	1		1	1			1
Enjoyed the instructors who were helpful and understanding	1		1		1	1	
ARTACT personnel were cooperative and flexible	1		1	1		1	
Working with professionals is a pleasure	1		1	1		1	
(Number of Students Responding to Cluster)	(4)	(0)	(4)	(2)	(2)	(3)	(1)
Positive Comments							
Enjoyed program, learned a lot; enjoyed thinking about actions	1		1		1	1	
All AOB students should participate on ARTACT	1	1		1			1
ARTACT allowed me to apply the curriculum in a practical manner	1	1		1			1
Outstanding learning experience	1		1		1	1	
Less boring and more efficient than terrain boards	1	1			1		1
(Number of Students Responding to Cluster)	(4)	(2)	(2)	(1)	(3)	(2)	(2)

(table continues)

Response Cluster Comment or Suggestion	Total Number of Responses	Event/Student Characteristic					
		Experienced Equipment Problems		Class Rank		Improvement in Tactical Knowledge	
		No	Yes	High	Low	High	Low
No Comments							
(Number of Students)	(11)	(9)	(2)	(7)	(4)	(6)	(5)